# FOREST TREE NURSERY EQUIPMENT REFERENCE CATALOGUE

## FOR THE PRODUCTION OF BAREROOT NURSERY STOCK IN ONTARIO

By
Forest Management Branch
1991

Forest Resource Development Agreement

Canada Ontario

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Addresses for the Crown Owned Tree Nurseries Operated by the Ontario Ministry of Natural Resources.

## INTRODUCTION

This reference catalogue describes the equipment currently used in the production of forest tree seedlings at Crown bareroot nurseries in Ontario.

A separate technical article has been compiled for each major type of equipment. The information presented in each article was obtained through consultation with nursery staff and equipment manufacturers in a four-part procedure.

1) All Crown nurseries were asked to inventory the equipment currently used to produce bareroot nursery stock. Functional groups, key equipment items and associated manufacturers were identified from the master equipment list produced.

2) Manufacturers were contacted to determine equipment availability, current models, pricing and specifications for each equipment type.

3) Representatives of Crown nurseries across Ontario were asked to complete detailed questionnaires and were subsequently interviewed in person to obtain comprehensive field comments about equipment uses, limitations, advantages and disadvantages.

4) Information thus obtained was compiled into draft articles which were sent to all nurseries for evaluation and to obtain additional comments from other nursery personnel.

Due to the non-scientific nature of the information-gathering procedure used, mention of manufacturers, models, or trade names shall in no way be deemed to constitute an official evaluation, recommendation, approval, or endorsement to the exclusion of others not mentioned herein.

## EXPLANATION OF THE LAYOUT AND CONTENT

A standard technical format has been used in writing the articles for this catalogue to facilitate comparison between equipment and enable rapid location of specific information.

The following is an explanation of the type of information that has been placed under some of the key section headings.

### OPERATIONAL GROUP

All equipment items have been grouped according to the main nursery activity with which they are associated. Thirteen operational categories were identified.

### EQUIPMENT TYPE

The standard name associated with the particular equipment item is displayed. A reference number relating this item to a particular operational group is also given.

### CURRENT USERS AND NUMBERS OF UNITS

Each Crown-owned tree nursery is listed. The numbers, and where possible the makes and/or models in use, are given for each nursery. Where the make cited is "MNR", Ministry personnel have fabricated or assembled the equipment themselves.

### PRICE OF CURRENT MODELS

Available prices are given in 1987 Canadian dollars unless otherwise noted.

### SPECIFICATIONS

Whenever possible, equipment specifications have been included for all makes and models currently in use and currently available. If specifications were not available for all models or if there were a large number of different models in use, a representative sample of equipment specifications or specifications of a model representative of the group as a whole were used in this section.

### OPTIONAL EQUIPMENT

This section displays any optional items associated with a particular piece of equipment. When there are several manufacturers items common to all are given.

### SPECIAL MODIFICATIONS

Modifications made by nursery staff to the stock implement or to the standard operating configuration are included.

### COMPLEMENTARY EQUIPMENT

Supplementary equipment that is used in conjunction with a particular type of equipment while it is performing its primary task is listed under this heading.

### PRIME MOVER

If a tractor or some form of motive force is required to operate the implement, this section describes the type, power rating, attachment particulars and any other special requirements of the implement.

### TASK PERFORMED

This section briefly describes the main uses for the particular implement in the production of forest tree seedlings.

### LIMITING FACTORS

Any factors that influence the normal operation of the implement are identified.

### SAFETY ASPECTS

Special safety precautions recommended by the manufacturers and by the nursery users of the implement are listed.

### MAINTENANCE

Many implements have special requirements beyond those considered to be standard daily maintenance. This section identifies particular maintenance requirements suggested by the manufacturer. Based on the experience of those using the implement, the most common repairs are identified along with a general assessment of the ease of repair and the availability of parts.

### USERS' ASSESSMENT

The nursery staff who use the equipment give their comments regarding the advantages and disadvantages of the particular implement as compared to other equipment or techniques.

**OPERATIONAL GROUP:**

1 Seed Treatment and Storage

**EQUIPMENT TYPE:**

**1.01** Refrigerated Seed Storage

**MAKES AND MODELS IN USE:**

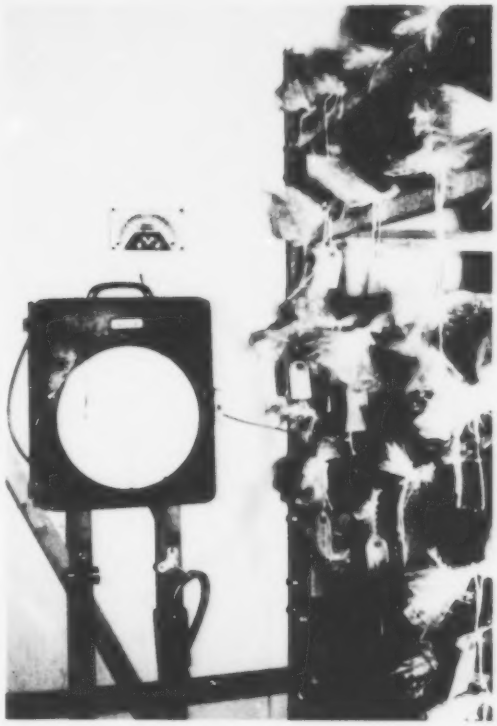
Refrigerated seed storage facilities vary widely from nursery to nursery. The facilities can be as simple as an upright refrigerator or as elaborate as a stand-alone, climate-controlled cold storage building.

This article describes the facility in use at Midhurst Tree Nursery in 1987. This facility lies between the two extremes of complexity noted above. Its basic features are representative of those that must be considered when planning any seed storage facility.

Cold storage facilities are best designed and installed by a refrigeration consultant or engineering firm.

**CURRENT USERS OF REFRIGERATED SEED STORAGE:**

| | |
|---|---|
| Chapleau | — |
| Dryden | — |
| Gogama | — |
| Kemptville | 1 |
| Midhurst | 1 |
| Orono | 1 |
| St. Williams | — |
| Swastika | — |
| Thessalon | — |
| Thunder Bay | 1 |



Refrigerated Seed Storage.

**TECHNICAL INFORMATION**

**SPECIFICATIONS:**

| | |
|---|---|
| Length | - 4.88 m |
| Width | - 3.66 m |
| Height | - 2.44 m |
| Insulation | - 10.2 cm fibreglass |
| Materials | - two-by-four construction |
| | - styrofoam sheeting , 5 cm thick |
| | - insulated cold-room door |
| Environmental Control | - Copeland refrigeration unit, 1.8 tonne capacity |
| | - 1x1000 watt baseboard heating unit |
| | - air circulation fan |
| | - 2 thermograph units |
| Capacity | - est. 300 kg seed |

**OPTIONAL EQUIPMENT:**

1) Humidity control mechanism.

**COMPLEMENTARY EQUIPMENT:**

1) Self-standing racks and shelves to support containers of seed in an efficient vertical arrangement.

2) Plastic storage bags (2 - 4 mil.) for seed storage. The storage bags must inhibit moisture loss while allowing gaseous exchange.

## TASK PERFORMED

The seed storage cooler is used primarily to stratify seeds in preparation for spring sowing.

## HOW IT WORKS

**GENERAL DESCRIPTION AND WORKING PRINCIPLE:**

The walk-in cooler, designed by refrigeration consultants, used for seed storage at Midhurst has a unique design that has been incorporated into the large seedling cold storage room.

The walls and ceiling of the room are framed in wood two-by-fours. Styrofoam sheeting forms the insulated wall and ceiling panels. A self-sealing, insulated cold-room door provides access to the room while effectively sealing the room from the external environment.

Environmental control of the cooler is achieved by a combination of devices for cooling, heating and air circulation. A 1.8 T capacity cooling unit reduces the temperature inside the cooler. Note, the cooling unit should be rated at a capacity that exceeds the calculated cold-room requirements by one-third to one-half. This is particularly important for facilities where there may be fluctuations in the temperature of the air surrounding the cooler.

Ideally the cooler temperature should range between 1 and 5 degrees with an average temperature of 3 to 4 Celsius. The cooling unit keeps the temperature from rising too high while the small baseboard heating unit injects heat into the cooler to keep the temperature from dropping too low. A circulating fan mounted within the cooler maintains airflow that mixes the air currents to keep the temperature constant throughout the cooler.

The current seed storage facility at Midhurst does not incorporate any means of controlling humidity. A future stand-alone seed storage facility planned for Midhurst will incorporate this feature.

To ensure consistent and adequate environmental control, two thermographs placed one at either end of the cooler record the temperature over time within the cooler. Heating, cooling or circulation may be adjusted.

**LIMITING FACTORS:**

1) Restricted to use with water-stratified seed.

2) Present cooler can hold approximately 300 kg of stratified seed. Cooler currently being designed will accommodate 450 kg of seed. The current requirements are approximately 300 kg annually.

3) Present facility has been designed to function only within the relatively cool environment of the seedling cold storage room. The

insulation and cooling unit would not be sufficient to maintain adequate low temperatures if the unit were placed in a normally heated room or in the hot summer air outdoors.

## OPERATIONAL INFORMATION

### STAFF REQUIREMENTS:

One person is required to monitor and maintain the operation of the cooler.

### MAINTENANCE:

**Daily** - Monitor thermographs to ensure all environmental control devices are functioning properly.

**Other** - Check and maintain cooling system as required by the manufacturer.

**Annually** - Approximately one month prior to commencement of the stratification for spring seeding, a cooling specialist should thoroughly inspect and repair the cooling unit.

**Special maintenance equipment required** - Maintenance contract for the cooling unit.

**Major repair items** - Cooling unit.

**Ease of repair** - Cooling unit specialist is required to properly repair and maintain the cooling unit.

**Parts availability** - Generally good. Will be dependent upon the make and the servicing arrangements.

## USERS' ASSESSMENT

### ADVANTAGES:

1) Can be built to accommodate a large volume of seeds. Simple refrigerators have considerably less capacity.

2) Because of the coldroom environment in which this unit operates, it requires less insulation and a smaller cooling unit to maintain the required environmental conditions. This translates to a relatively lower construction cost.

### DISADVANTAGES:

1) The area occupied by the seed storage room reduces the available space within the seedling cold storage facility for stacking bagged or boxed seedlings. This is a disadvantage if the volume of seedlings requiring cold storage is already at or approaching the capacity of the main coldroom.

2) The environmental control equipment and the basic construction of this seed storage facility are insufficient to maintain an adequate seed storage environment if the facility were removed from the seedling cold storage room or if the main room-cooling system were not in operation. The use of this facility is therefore limited to winter and spring when the main coldroom provides sufficiently cold environment.

3) The present design has no humidity control.

**OPERATIONAL GROUP:**

**1** Seed Treatment and Storage

**EQUIPMENT TYPE:**

**1.02** Seed Drying Screens

**MAKES AND MODELS IN USE:**

Nursery-fabricated

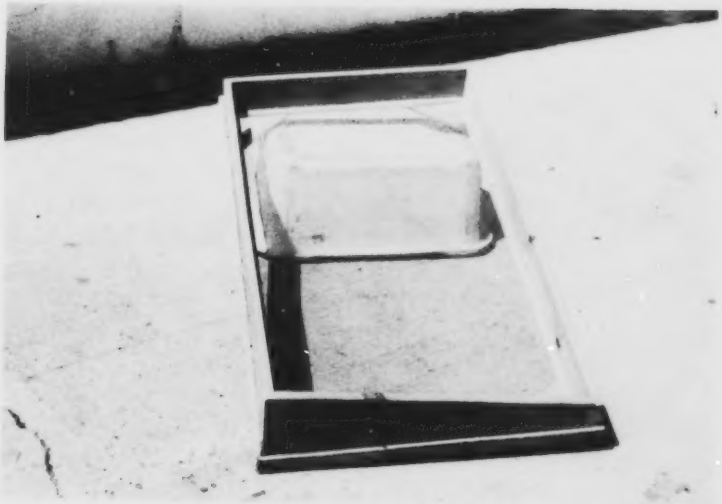
**MANUFACTURERS AND DISTRIBUTORS:**

The units described were fabricated by the staff of the Kemptville Nursery. The design is such that they may be quickly fabricated as required.

**CURRENT USERS AND NUMBER OF UNITS:**

| | |
|---|---|
| Chapleau | — |
| Dryden | — |
| Gogama | Y |
| Kemptville | Y |
| Midhurst | — |
| Orono | — |
| St. Williams | — |
| Swastika | Y |
| Thessalon | — |
| Thunder Bay | Y |

Note "Y" indicates that drying racks and screens are in use. Numbers are not included.



Seed drying screen — Kemptville Nursery.

## TECHNICAL INFORMATION

**SPECIFICATIONS:**

| | |
|---|---|
| Length | - 116.8 cm |
| Width | - 64.8 cm |
| Depth of Sides | - 10.2 cm |
| Depth at Funnel Corner | - 19.1 cm |

Note: For further details see Figure 1.

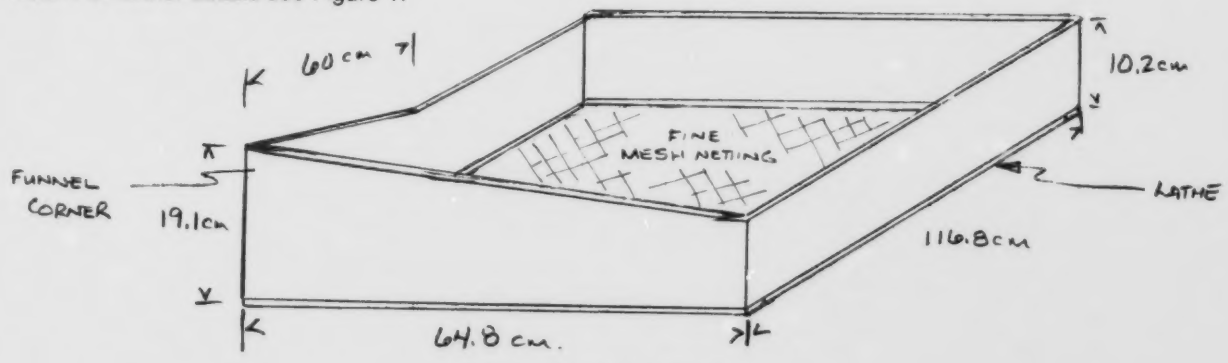



Figure 1 - Seed Drying Screen

**OPTIONAL EQUIPMENT:**

1) Racks for stacking seed-drying trays minimize the floor space required and facilitate air flow around the screened trays.

**SPECIAL MODIFICATIONS:**

One corner of each tray may be deepened and the sides tapered to form a funnel-like arrangement that assists in pouring seeds from the rack into seed containers.

## TASK PERFORMED

The screens are used for air-drying seed in preparation for sowing. They are also used for seed rinsing.

## HOW IT WORKS

**WORKING PRINCIPLES:**

Soaked seed is spread out evenly in trays with mesh bottoms. The mesh allows the excess moisture to drain off and drying air to reach the seeds on all sides.

**GENERAL DESCRIPTION:**

A seed-drying tray consists of a shallow rectangular wooden frame with a mesh bottom. The wooden sides of the frame are vertical and approximately 10 cm deep so that they serve as shallow containing walls.

To make it easier to pour seed from the frame, one corner of the frame is extended to a height of 19 cm. The side and end adjacent to the peaked corner taper towards the peak and act as a funnel when pouring seeds.

Mesh material is stretched tightly across the bottom of the frame. The size of the mesh selected is important, since it must allow moisture to drain away, facilitate air circulation, and also contain the seeds. Fine mesh material such as mosquito netting is used for species with small seeds such as black spruce and white spruce. For species with larger sized seeds, such as red pine, white pine and scotch pine, regular window screening is used.

Strips of wooden lath are nailed over the mesh into the underside of the frame. This prevents seed leakage by holding the mesh firmly against the frame to eliminate the development of loose creases where the mesh joins the frame.

## OPERATIONAL INFORMATION

**STAFF REQUIREMENTS:**

One person is required to set up the drying trays and ensure that the seeds do not become too dry.

**MAINTENANCE:**

On average the screens are replaced once every two years. The mesh should be inspected and re-tacked as required.

**Special maintenance equipment required** - None.

**Major repair items** - None.

**Ease of repair** - Very good.

**Parts Availability** - Very good.

Materials can be obtained at most lumber yards and hardware stores.

**USERS' ASSESSMENT**

**ADVANTAGES:**

1) Portable, light-weight, able to be handled by one person easily.

**DISADVANTAGES:**

None noted.

**OPERATIONAL GROUP:**

**1** Seed Treatment and Storage

**EQUIPMENT TYPE:**

**1.03** Seed Pelletizing (Cement) Mixer

**MAKES AND MODELS IN USE:**

The mixers in use at Ontario tree nurseries have been fabricated by MNR staff or are simple modifications of standard mixers available at most hardware and building supply stores.

**MANUFACTURERS AND DISTRIBUTORS:**

Various brand names.

Most units currently available are suitable.

**CURRENT USERS AND NUMBER OF UNITS:**

| | |
|---|---|
| Chapleau | — |
| Dryden | 2 |
| Gogama | — |
| Kemptville | 1 |
| Midhurst | 1 |
| Orono | — |
| St. Williams | 1 |
| Swastika | 1 |
| Thessalon | — |
| Thunder Bay | — |

**PRICE OF CURRENT MODELS:**

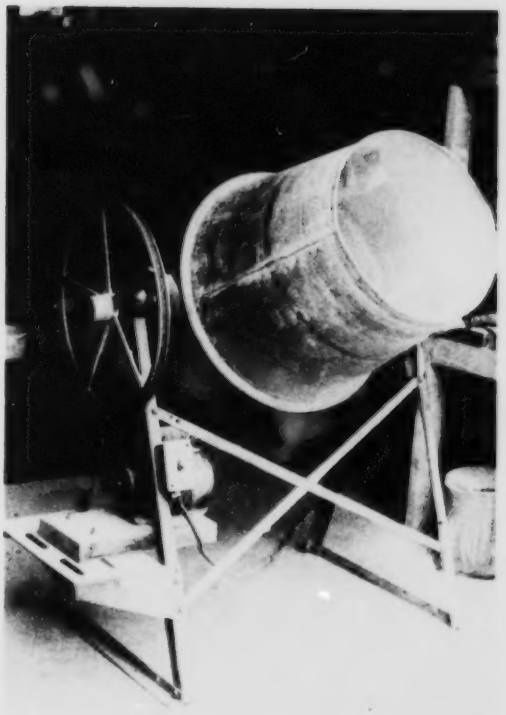
$150.00 est. for materials.

**TECHNICAL INFORMATION**

**SPECIFICATIONS:**

(Typical)

| | |
|---|---|
| Maximum Height | - 134.6 cm |
| Drive System | - Belt and pulley drive |
| Motor | - 1/3 horsepower electric motor, 120 volt AC |
| Drum: | |
| Length | - 53.3 cm |
| Width Opening | - 43.2 cm |
| Capacity | - 0.25 m3 |
| Number of Baffles | - 3 |
| Baffle Height | - 7.6 cm |
| Baffle Length | - 44.5 cm |



Seed pelletizing mixer — Midhurst Nursery.

**SPECIAL MODIFICATIONS:**

1) Roller wheels mounted under frame improve the mobility of the unit. During operation the mixer is often moved next to a large open door in the seed shed to maintain adequate ventilation. (Midhurst Nursery)

2) Mixing baffles within the drum were tapered from 7.6 cm at the base of the drum to 2.5 cm near the drum opening. The taper makes it easier for the operator to manipulate a small broom inside of the drum when seed and latex become bunched at the base of the drum. (Midhurst Nursery)

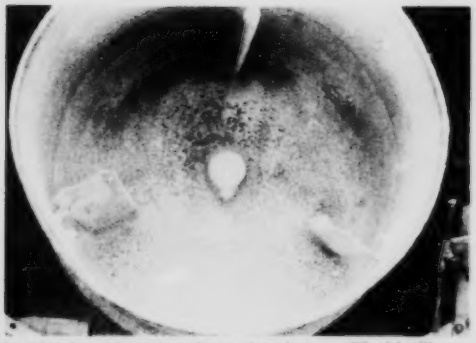
**COMPLEMENTARY EQUIPMENT:**

1) 20-litre polyethylene tubs.

2) Plastic pails for carrying seed.

**TASK PERFORMED**

Cement mixers are used for pelletizing tree seed: the process whereby individual seeds are coated with a layer of fungicide to prevent soil-borne fungi from attacking the seed after it is sown.



Inside view of mixing drum showing modified baffles — Midhurst Nursery.

**HOW IT WORKS**

**WORKING PRINCIPLE:**

Seed is placed in a rotating drum. The rotation of the drum in conjunction with the agitating effect of horizontal baffles within the drum impart a tumbling action to the seed. Latex and dry powdered fungicide are put into the drum along with the seed. The tacky latex serves as the binding material that coats the seeds and causes the powdered fungicide to adhere to the seed surface.

**GENERAL DESCRIPTION:**

The electric cement mixer used for pelletizing seed is an open-ended rotating drum supported by an angle-iron frame.

An electric motor mounted on the side of the frame is connected, via pulleys and a belt drive, to an axle running across the frame. A 90-degree rotating hub located midway across this axle connects to the base of the drum at its axis so that it transfers rotation to the drum.

The drum is normally egg-shaped, with an opening at the smaller end. Three or four vertical baffles are affixed to the inside of the drum to ensure that materials in the drum are thoroughly agitated as the drum revolves.

During the mixing operation the drum is oriented at a 45 degree angle from vertical. At this angle materials are held in by the upward slope to the opening.

To facilitate the dumping of materials from the drum, swivel bearings are mounted around the main axle to allow the operator to swing the drum up through vertical and over towards the opposite side of the frame at an angle of approximately 135° from vertical. In this position the opening slopes downwards and the materials flow out through the opening.

**LIMITING FACTORS:**

1) Seed must be reasonably dry for effective pelletizing. If the surface of the seed is wet the latex will not bind to the surface of the seeds. Water-stratified seed is too wet for proper coating.

2) Operator training is important. An inexperienced operator may not properly coat the seed.

## OPERATIONAL INFORMATION

**STAFF REQUIREMENTS:**

One person is required to load seed, add the correct proportions of latex and captan, start and stop the machine, and unload the coated seed.

**SAFETY ASPECTS:**

1) Loose clothing should not be worn while operating the unit, as it might become caught in the belts and pulleys and cause injury.

2) Goggles, coveralls, a respirator and neoprene gloves should be worn to protect the operator from the fungicide dust.

3) The unit should only be operated in a well-ventilated environment.

**MAINTENANCE:**

**Daily** - After each use, clean and rinse the drum to eliminate any buildup of fungicide or latex.

**Other** - Grease the bearings, occasionally.

- Regularly inspect belts, replacing as required.

**Special maintenance equipment required** - None.

**Major repair items** - Belts.

**Ease of repair** - Very good.

**Parts availability** - Very good.

**PRODUCTION RATES:**

5 to 8 kg per load.

Note: Actual load size will vary with the species and the seed size.

## USERS' ASSESSMENT

**ADVANTAGES:**

1) Cement mixers provide a relatively inexpensive and simple means of coating seed for controlling potential fungi attacks on young germinant seedlings in the field.

**DISADVANTAGES:**

None noted.

**OPERATIONAL GROUP:**

**2** Ground Preparation

**EQUIPMENT TYPE:**

**2.01** Chisel Ploughs

**MAKES AND MODELS IN USE:**

1) International, Model N/A
2) John Deere, Models 740 and 1610
3) Kverneland, 5 Tine

**MANUFACTURERS AND DISTRIBUTORS:**

1) International Harvester

   The agricultural equipment division now operated by J.I. Case Canada under the name Case - International.

   J.I. Case Ltd.
   3350 South Service Road,
   Burlington, Ontario
   L7N 3M6

   Telephone: (416) 632-3800

   Distributors: Dealerships located across Ontario.

2) John Deere Ltd.,
   P.O. Box 1000,
   Grimsby, Ontario
   L3M 4H5

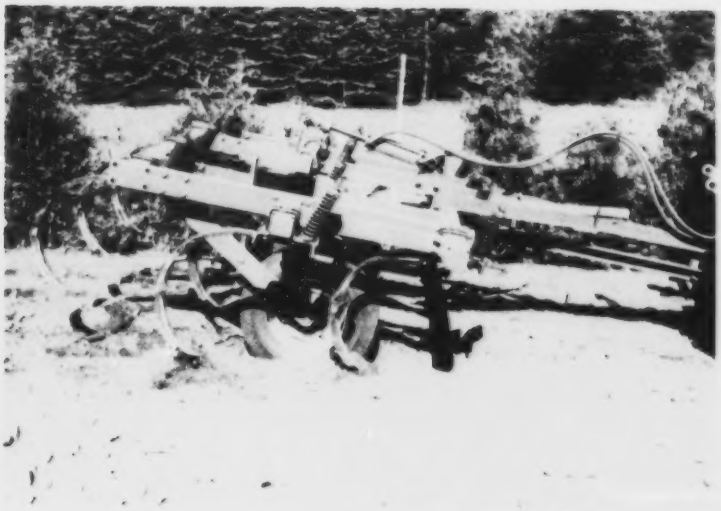
   Telephone: (416) 945-9281

   Distributors: John Deere dealerships throughout Ontario.

3) Kverneland A/S,
   N-4344 Kverneland,
   Norway

   Distributors: Nor-Can Canada Ltd.
   P.O. Box 1237,
   Cambridge, Ontario
   N1R 6C9

   Telephone: (519) 623-8261



Chisel plow — Thunder Bay Nursery.

**CURRENT USERS AND NUMBER OF UNITS:**

| | | |
|---|---|---|
| Chapleau | 1 | John Deere 1610 |
| Dryden | - | |
| Gogama | 1 | Locally fabricated |
| Kemptville | - | |
| Midhurst | 1 | Kverneland 5 tine |
| Orono | 1 | Grub |
| St. Williams | 1 | Locally fabricated |
| Swastika | 1 | John Deere 740 |
| Thessalon | - | |
| Thunder Bay | 1 | International |

Note: Grub equipment is no longer available.

## TECHNICAL INFORMATION

**SPECIFICATIONS:**

The following specifications are typical of most models currently available and in use.

| | |
|---|---|
| Length | - 6.2 m |
| Working Widths | - 2.13 - 16.15 m |
| Working Depths | - Maximum 38 cm |
| Depth Control | - Gauge wheels optional on three-point hitch models |
| | - Master/slave hydraulic cylinder system on trailing models |

Note: On trailing models with self-leveling hitches there is a mechanical crank to adjust depth control on the tongue

| | |
|---|---|
| Hitch | - Category 2 or 3, three-point hitch or clevis-type trailing draw-bar |
| | - Automatic self-leveling frame |
| Wheels | - 30 - 38 cm rims |
| | - 9.5-14, 9.5-15, 7.6-15 tires |
| Transport Width | - 2.13 - 4.57 m |
| Transport Height | - Maximum 5.3 m, dependent upon the working width |
| Shank Spacing | - 30.5 cm |
| Vertical Clearance | - 61.3 cm from point of ground tools to the frame |
| Shank Bar Spacing | - 76.2 cm between front and rear bars |
| Obstacle Clearance | - 19.6 cm with spring-cushion shanks |
| Shanks | - Spring-Cushion design standard 3.2 x 5.1 x 63.5 cm Coil Spring assembly |
| Frame | - 10.2 x 10.2 cm tube steel |

**OPTIONAL EQUIPMENT:**

1) Soil mulcher attachment.
2) Rigid chisel shanks.
3) Various styles of replacement points, sweeps and shovels.

**SPECIAL MODIFICATIONS:**

None

## PRIME MOVER

**TYPE:**

Standard agriculture tractor

Four-wheel drive recommended

**NET POWER REQUIREMENT:**

Minimum of 45 kw

**ATTACHMENT:**

Clevis hitch and draw-bar (typically)

Three-point hitch on some models

## TASK PERFORMED

Chisel ploughs are used for primary tillage and to break up hardpan and compaction to depths of 30 to 38 cm.

## HOW IT WORKS

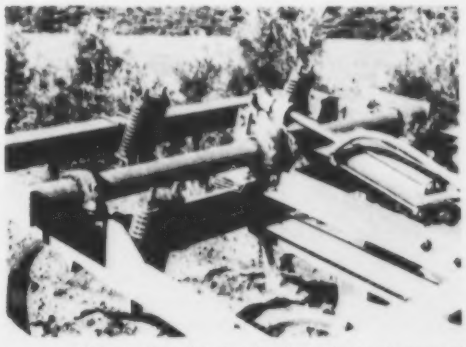
**WORKING PRINCIPLE:**

Narrow vertical tines with chisel points extend down into the soil to a depth of up to 38 cm. The deep action of the chisels loosen compacted soil while mixing soil and surface litter by the churning action of the tines.

**GENERAL DESCRIPTION:**

A chisel plough consists of a heavy steel frame to which a series of heavy chisel tines are mounted. The chisels are curved, hardened steel shanks with replaceable tips. The shanks are rigidly clamped to the frame members, or may in some cases be mounted with heavy spring-loaded pivots that allow the shanks to pivot back when an obstruction is encountered. Different sizes and styles of replacement tips are available to match different field conditions and uses. The unit is towed from either the three-point hitch or the draw-bar of a standard agricultural tractor. Larger units may have hinged extensions on the frame that fold down during operation of the unit to extend operating width and are hydraulically raised for transport along roadways and narrow paths.

Most models of chisel plough possess wheels that hydraulically raise the unit for transport and lower it during operation. The wheels determine the depth of operation and maintain all chisels at the same level. Note: on three-point hitch versions the wheels are optional.



Chisel plow details showing shank pivots and hydraulic raising mechanism.

**LIMITING FACTORS:**

1) Soil compaction can limit the operating depth of the unit and the speed of operation.

## OPERATIONAL INFORMATION

**STAFF REQUIREMENTS:**

One person is required to drive the tractor.

**SAFETY ASPECTS:**

Standard agricultural safety procedures should be observed.

**MAINTENANCE:**

**Daily** - Grease all fittings.

**Other** - Regularly inspect all tines for indications of excessive wear or damage. Check all nuts and bolts to ensure that all are tightened to manufacturer's specifications.

**Special maintenance equipment required** - None.

**Major repair items** - Replacement of chisel points as they wear with use.

**Ease of Repair** - Very good. All parts of the unit are readily accessible.

**Parts availability** - Very good. Equipment in use is usually made by large reputable companies with good parts supplies.

**PRODUCTION RATES:**

1 ha per hour.

Note that the actual production rate will vary with the depth of operation and the degree of soil compaction.

## USERS' ASSESSMENT

**ADVANTAGES:**

1) The chisel plough can be used for both primary and secondary tillage functions around the nursery. Different replaceable tine points are available for different soil conditions and different jobs.

2) The chisel plough can operate at a greater maximum depth than a standard mouldboard plough. The unit can therefore be used for light subsoiling duties.

3) The chisel plough is much simpler to set up and adjust than the mouldboard plough.

**DISADVANTAGES:**

1) The unit does not turn over and mix the soil as well as a mouldboard plough.

**OPERATIONAL GROUP:**

**2** Ground Preparation

**EQUIPMENT TYPE :**

**2.02** Mouldboard Ploughs

**MAKES AND MODELS IN USE:**

1) Ford Models 101, 140
2) International Harvester, Model 36
3) John Deere, Model 45
4) Kverneland, Model A, 3 furrow
5) Massey Ferguson, Model 10, 3-furrow; 43, 3-furrow; 66, 2-furrow

**MANUFACTURERS AND DISTRIBUTORS:**

1) Ford - New Holland of Canada Ltd.,
   Toronto Branch,
   P.O. Box 7000,
   Brampton, Ontario
   L6V 2M9

   Telephone: (416) 457-2720

   Fax: (416) 457-6446

   Distributors: Ford dealerships throughout Ontario.

2) International Harvester

   Note: International Harvester is now operated by J.I. Case Canada under the name Case-International.

   J.I. Case Canada,
   3350 South Service Road,
   Burlington, Ontario
   L7N 3M6

   Telephone: (416) 632-3800

   Distributors: Case International dealership throughout Ontario.

3) John Deere Ltd.,
   P.O. Box 1000,
   Grimsby, Ontario
   L3M 4H5

   Telephone: (416) 945-9281

   Distributors: John Deere dealerships throughout Ontario.

4) Kverneland A/S
   N-4344 Kverneland,
   Norway

   Distributor: Nor-Can Farm Equipment Ltd.,
   P.O. Box 1237,
   Cambridge, Ontario
   N1R 6C9

   Telephone: (519) 623-8261

3 furrow plow — Midhurst Nursery.

5) Massey Ferguson Industries Ltd.,
954 King Street West,
Toronto, Ontario
M6K 1E5

Telephone: (416) 593-3811 (Varity Corporation)

Distributors: Massey Ferguson dealerships across Ontario.

**CURRENT USERS AND NUMBER OF UNITS:**

| | | |
|---|---|---|
| Chapleau | 1 Massey-Ferguson 3-frw | |
| Dryden | 1 Massey-Ferguson 3-frw | |
| Gogama | 1 Massey-Ferguson 2-frw | |
| Kemptville | 1 International 420 3-frw | |
| Midhurst | 1 Kverneland 3 Frw | 1 Ford 3 Frw |
| Orono | 1 International 420 3-frw | |
| St. Williams | 1 International 36 3-frw | |
| Swastika | 1 International 420 3-frw | 1 Ford 3 Frw |
| Thessalon | 1 International 420 3-frw | |
| Thunder Bay | 1 John Deere | |

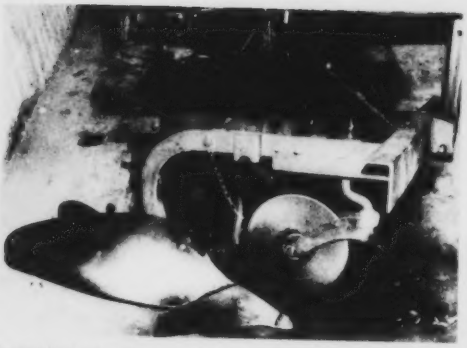
## TECHNICAL INFORMATION

### SPECIFICATIONS:

The following is a summary of the range of specifications available on the major makes and models currently available on the market.

The specifications for the Case-International Model 420 three-furrow plough are included as a listing of the dimensions and features typical of mouldboard ploughs in use at Ontario tree nurseries. The Model 420 is the most common model in use.

| | **General** | **International 420** |
|---|---|---|
| Number of Bottoms | 2 to 18 | 3 |
| Bottom Size | 30 - 41 cm | 36 cm |
| Max. Plough Depth | 30 cm | 25 cm |
| Furrow Construction | Tubular steel | Tubular steel |
| Vertical Clearance(cm) | 67 - 100 | 67 |
| Beam Type | Rigid/ Auto reset | Auto reset |
| Frame Hitch | Two-point | Three-point |
| | - on land | |
| | - in furrow | |
| | Rigid trailing | |
| | Hinged trailing | |
| | Three point | |
| Coulters | Independent | Independent |
| | Free-swinging | Free swinging |
| | Plain/rippled | Plain |



Individual plow body with leaf-spring reset mount.

trailing mount to the draw-bar.

Each plough body includes a share, a share point, a mouldboard, and a landside.

The share is heavy steel plate that is horizontally mounted and diagonally oriented with respect to the direction of travel. The share functions as an angled wedge that cuts into and lifts the soil along the bottom of the newly created furrow.

The share point is a small sharpened steel plate affixed to the forward point of the share, which reduces wear on the forward edge of the share and thereby the frequency of plough share replacements. The share point is a point of maximum wear, since it is the first part of the plough to cut through the soil and encounter any obstructions. When the point becomes dull or damaged it can be reversed or replaced in order to maintain a sharp edge.

Behind the plough share is a large curved plate called the mouldboard. The mouldboard creates the twisting action crucial for the proper function of the plough. As the soil ribbon rides up from the share onto the mouldboard, it is cut vertically by the front edge of the mouldboard, called the shinpiece. The twist in the plate then flips the soil over against the previous furrow.

On the side of the plough assembly opposite the mouldboard, a vertical plate called the landside presses against the cut side of the furrow, counteracting the force exerted by the soil pressing against the share and mouldboard assembly. These forces would otherwise cause the unit to veer towards the side opposite the overturned furrow.

When more than one plough head is used, they are always mounted to the frame in a staggered fashion. With this arrangement each individual ploughing head is able to counteract the transverse forces generated before the furrow edge created by the plough head is cut away by the next plough head. The force-cancelling action of each plough head prevents the entire plough from twisting and veering to the side.

Each plough assembly is mounted to the main frame of the unit by a heavy non-flexible shank. On some models the shanks are attached to the frame by rigid mounts, which incorporate a shearbolt that will snap when the head hits an obstruction. When this occurs the plough body assembly swivels backwards to prevent serious damage.

Alternate mounting designs have eliminated the shear bolt and replaced it with a coil or leaf-spring arrangement, referred to as an automatic reset mount. The spring arrangement allows the plough body to swing back upon impact and then snap back into operating position without requiring the replacement of the shear bolts. To prevent the device from tripping under the pressures of normal operation and still prevent damage from obstructions, the spring assembly is designed to exert maximum pressure when the plough head is in the operating position. Pressure decreases rapidly once the unit begins to trip so that the head can easily tip up to prevent damage.

Some models of mouldboard plough incorporate rolling coulters in front, and slightly towards the landside, of each plough body. The coulters reduce the pressure on the vertical edge or shinpiece of the plough buy pre-scoring the furrow and cutting through any roots and debris in or on the soil.

**LIMITING FACTORS:**

1) Too much or too little soil moisture reduces the effectiveness of the plough. When the soil is too dry it does not adhere well enough to form a ribbon of soil that can be properly lifted and flipped by the plough. When the soil is too wet it will not undergo the required horizontal and vertical fracturing.

2) Operator experience is important: the most efficient and effective operation can only be obtained through proper setup, adjustment and operation.

3) Additional attachments and dull edges increase the draft of the implement, thereby requiring increased tractor power to operate.

## OPERATIONAL INFORMATION

**STAFF REQUIREMENTS:**

One person is required to operate the plough.

**SAFETY ASPECTS:**

Standard safety practices for agricultural machinery.

**MAINTENANCE:**

**Daily** - Grease all moving parts (e.g. disc coulter, and depth wheel, if so equipped).

**Seasonal** - Grease exposed metal surfaces for winter storage.

Before storing mouldboard ploughs equipped with auto reset, slacken tension springs. Before retightening the springs, trip several times to ensure that the beam mechanism is moving freely enough.

**Special maintenance equipment required** - None.

**Major repair items** - Plough points.

**Ease of repair** - Very good. All parts of the unit are easily accessible.

**Parts availability** - Very good. Most makes in use are produced by large, reputable companies with province-wide dealers and good parts supplies. Since these implements are widely used in the agricultural industry, parts are easily available.

**PRODUCTION RATES:**

0.6 to 0.8 ha/ hour.

## USERS' ASSESSMENT

**ADVANTAGES:**

1) Mouldboard ploughs turn soil over better than the chisel ploughs.

**DISADVANTAGES:**

1) Repeated use of this implement causes the formation of a hardpan below the plough layer.

| | | |
|---|---|---|
| Coulter Mountings | Compression or shear-bolt | Compression |
| Wheels | Std. or Opt. (Depends on model and mount type.) | Optional |

**OPTIONAL EQUIPMENT:**

1) General purpose, high-speed, and deep-tilling plough bottoms are available.

2) Various sizes and styles of coulters.

3) A modified type of share point called a share knife may be used as a replacement for regular points. The share knife is an alternative to disc coulters when problems with stones and trash are encountered.

4) Rear depth wheels on mounted plough eliminate the need for continual adjustment of the tractor depth control.

**SPECIAL MODIFICATIONS:**

1) Midhurst Nursery has modified one of its plough units so that it can be used for trenching and healing in hardwood seedlings in preparation for winter storage. The modification reduces the plough to a single furrow and places the plough body off to the right side of the tractor outside wheel track. The extreme offset of the plough body enables the tractor to turn over a furrow to heal in hardwood seedlings without having to straddle the trench and the seedlings.

## PRIME MOVER

**TYPE:**

Standard agricultural tractor

**NET POWER REQUIREMENT:**

A minimum of 29.8 to 37.3 kw for a three-furrow plough

**ATTACHMENT:**

Three-point hitch

## TASK PERFORMED

The unit is used to turn over the upper 30 to 40 cm of soil to incorporate surface litter or a cover crop into the soil and loosen compacted soil.

## HOW IT WORKS

**WORKING PRINCIPLE:**

The mouldboard plough operates on the principle of a double twisted wedge. As the plough advances, soil is lifted by an angled vertical wedge and pushed over to one side by a horizontally oriented wedge. The double wedge is fabricated with a twist so that it will lift a strip of soil and flip it over to one side.

**GENERAL DESCRIPTION:**

A mouldboard plough consists of one or more ploughing units mounted to a heavy tube-steel frame. The frame is attached to the tractor through the three-point hitch, a partial three-point hitch mount, or a

**OPERATIONAL GROUP:**

**2** Ground Preparation

**EQUIPMENT TYPE :**

**2.03** Discs

**MAKES AND MODELS IN USE:**

1) Bush Hog, Model 145

2) Ford, Series 241

3) International, Model 370, 350. - Model 122.

4) John Deere, Model 105, 225

5) Massey Ferguson, Model 25

6) Massey Harris, Model N/A

7) McCormick, Model U-F-36

Note: Massey-Harris and McCormick makes are no longer available.

Bush hog offset discs — Midhurst Nursery.

**MANUFACTURERS AND DISTRIBUTORS:**

1) Bush Hog Implements,
Allied Products Corporation,
P.O. Box 1039,
Selma, Alabama,
36701 U.S.A.

Telephone: (205) 872-6261

Distributor - Dare Young Sales Limited,
P.O. Box 147,
Bowmanville, Ontario
L1C 3K9

Telephone: (416) 623-5011

2) Ford - New Holland of Canada Ltd.,
Toronto Branch,
P.O. Box 7000,
Brampton, Ontario
L6V 2M9

Telephone: (416) 457-2720

Fax: (416) 457-6446

Distributors - Dealerships across Ontario.

3) International Harvester Company,

The farm equipment division is now operated by J.I. Case Canada under the name Case - International.

J.I. Case Canada,
3350 South Service Road,
Burlington, Ontario
L7N 3M6

Telephone: (416) 632-3800

Distributors - Dealerships located across Ontario.

4) John Deere Ltd.,
P.O. Box 1000,
Grimsby, Ontario
L3M 4H5

Telephone (416) 945-9281

Distributors - Dealerships located across Ontario.

5) Massey-Ferguson Industries Limited,
54 King Street West,
Toronto, Ontario
M6K 1E5

Telephone: (416) 593-3811 (Varity Corporation)

Distributors - Dealerships located across Ontario.

**CURRENT USERS AND NUMBER OF UNITS:**

| | |
|---|---|
| Chapleau | 1 (5) |
| Dryden | 1 (3) |
| Gogama | 1 (4) |
| Kemptville | 1 (2) |
| Midhurst | 1 (6) |
| Orono | 1 (1) |
| St. Williams | 1(1) |
| Swastika | 1 (3), 1 (4), 1 (7) |
| Thessalon | 1 (3) |
| Thunder Bay | 2 (1) |

Note: (1) International (2) Ford (3) John Deere (4) Massey-Ferguson (5) Massey-Harris (6) Bush Hog (7) McCormick

## TECHNICAL INFORMATION

**SPECIFICATIONS:**

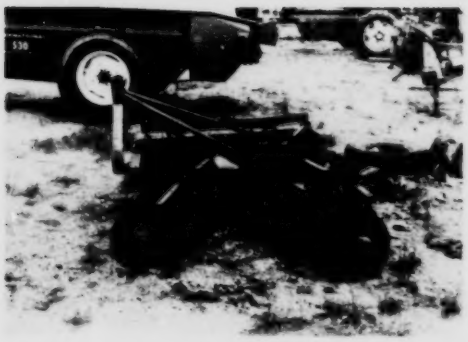
The following is a summary of the specification ranges for the equipment which is currently available on the market.

| Type | **Tandem discs** | **Offset discs** |
|---|---|---|
| Hitch Type | Clevis | Clevis |
| Hinged clevis | 3 PH cat. 1 | |
| Width | 178 - 640 cm | 170 -310 cm |
| Weight | 367 - 2443 kg | N/A |
| Blade Spacing | 19.0 - 22.9 cm | 22.9 - 25.4 cm |
| Blade Types | - Plain | - Plain |
| | - Notched | - Notched |
| Blade Weight | 21.0 - 47.7 kg | 63.0 - 74.0 kg |
| Gang Angle | - Adjustable | - Adjustable |
| Frame | - Heavy-walled, | - Torsion or rigid design |
| | - 10 cm squared tubing | |

## TASK PERFORMED

At nurseries, discs are used primarily for secondary tillage following ploughing. Discs level out plow furrows, seal soil surfaces, break up soil clods and mix the soil.

When used for primary tillage, discs are used to cut off and bury vegetation in fallow compartments and fire breaks.



Light duty tandem disc harrows — Midhurst Nursery.

Close-up of discs and disc gang mounting arrangement.

## HOW IT WORKS

### GENERAL DESCRIPTION AND WORKING PRINCIPLE:

Disc harrows consist of a heavy frame onto which two or four gangs of discs are mounted. Units with two angled gangs are referred to as offset harrows while units with four gangs are termed tandem harrows.

On a simple set of offset disc harrows, the front gang cuts a series of furrows into the soil surface. The right-facing orientation of the concave discs and the angle of the gang with respect to the direction of travel cause the soil to be turned over to the right.

The rear gang is reversed so that the concave disc surfaces face left and the gang angle is opposite to that of the front gang. Soil that was turned over to the right by the front gang is now turned back over to the left. This double turning action causes the characteristic soil mixing and breaking action of the discs.

Tandem disc harrows operate on the same basic principles but are constructed like two sets of offset discs reversed and mounted side by side. The two adjacent front gangs each turn to swath of soil out from the centre of the unit. The rear gangs then turn the soil back in towards the center of the unit.

Individual gangs are composed of a series of concave discs mounted side by side on a heavy axle. The gangs are suspended from the frame by two or three solid or cushioned hangers with axle bearings.

The discs in a gang are oriented so that the concave surfaces are directed forwards. The forward edge of each disc slices into the soil. The soil slides back along the concave surface of the disc and is subsequently turned over by the curvature and rotation of the disc.

Normally, solid concave discs are used for most nursery applications. For operation in stony soils or soils where there is considerable vegetative material, notched discs may be used.

Large versions of the tandem harrow have hydraulically operated, folding, frame extensions that reduce the width for transport between fields and along roads.

Most trailing units with a draw-bar attachment use hydraulically operated pneumatic wheels to lift the gangs clear of the ground for transport.

### LIMITING FACTORS:

1) Too wet a soil greatly diminishes the effectiveness of the discing action for mixing and uprooting weeds. The tendency is for the weeds simply to be transplanted.

## OPERATIONAL INFORMATION

### STAFF REQUIREMENTS:

One tractor driver is required.

### SAFETY ASPECTS:

Standard safety practices for the proper use of agricultural machinery.

### MAINTENANCE:

**Daily** - Grease gangs, wheels and any hinge points on the frame.

**Other** - Regularly inspect discs for damage and check mounts for tightness.

**Special maintenance equipment required** - None.

**Major repair items** - Worn and damaged discs must be replaced. In normal operation one set will last approximately two years.

**Ease of repair** - Downtime due to disc replacement varies with the location of the disc or discs to be replaced. Extended downtime should be expected if the discs to be replaced are located in the center portion of the gang axle.

**Parts availability** - Discs are used widely in agriculture, which ensures good parts availability for most makes.

### PRODUCTION RATES:

1.01 to 1.21 ha/hour.

## USERS' ASSESSMENT

### ADVANTAGES:

1) Offset discs leave only a single trough in the path of the unit, which is eliminated by overlapping adjacent passes.

2) Discs are relatively simple to set up and operate compared to implements such as the mouldboard plough.

### DISADVANTAGES:

1) Tandem disc harrows leave shallow trough on the outer edge on either side of the disced area behind the unit. The two troughs are not easily eliminated as with offset discs.

2) Discs are not as adaptable as mouldboard plows and chisel ploughs to different soil conditions and uses.

**OPTIONAL EQUIPMENT:**

1) Circular or notched disc blades.

2) Disc blade scrapers to prevent soil build-up on the disc blades.

3) Center tooth attachment cuts out the ridge normally left between the front gangs.

4) Furrow filler kit to minimize furrow normally left by outer blades.

Note: For most nursery applications the smaller models of discs are sufficient. The specifications for the Case - International Model 370 which fcllow are typical of the size of equipment required for most tree nursery use.

| | |
|---|---|
| Manufacturer | Case - International |
| Type | **Tandem disc harrows** |
| Hitch Type | - Clevis |
| Cutting Width | 351 - 422 cm |
| Transport Width | 361 - 432 cm |
| Blade Diameter | 45.7 / 50.8 cm |
| Blade Spacing | 19.1 - 22.9 cm |
| Bearings | - Triple sealed, regreasable |
| Weight | 1126 - 1244 kg |
| Disc Blades | - Solid round |
| Gangs | - Adjustable gang angle |
| Frame | - Steel torsion frame |
| | - Hand crank frame levelling |
| Wheels | - four-bolt wheels with tapered roller bearings, |
| | 35.6 or 38.1 cm |
| Wheel separation | 2.87 m |

Optional Items:

Soil mulcher attachment with vibrating coil tine teeth for fine finishing of seedbeds.

Self-levelling hitch.

**PRIME MOVER**

**TYPE:**

Standard agricultural tractor with hydraulics.

**NET POWER REQUIREMENT:**

A minimum of 37 kw.

**ATTACHMENT:**

Draw-bar or three-point hitch depending upon the model.

**OPERATIONAL GROUP**

**2** Ground Preparation

**EQUIPMENT TYPE**

**2.04** Diamond-Tooth Harrows

**MAKES AND MODELS IN USE:**

1) Inland Steel and Forgings Ltd.,
675 Washington Avenue,
Winnipeg, Manitoba
R2K 1M4

**DISTRIBUTORS:**

1) Eastern Farm Machinery Ltd.,
340 Edinburg Road North,
Guelph, Ontario
N1H 6P1

Telephone: (519) 836-2400

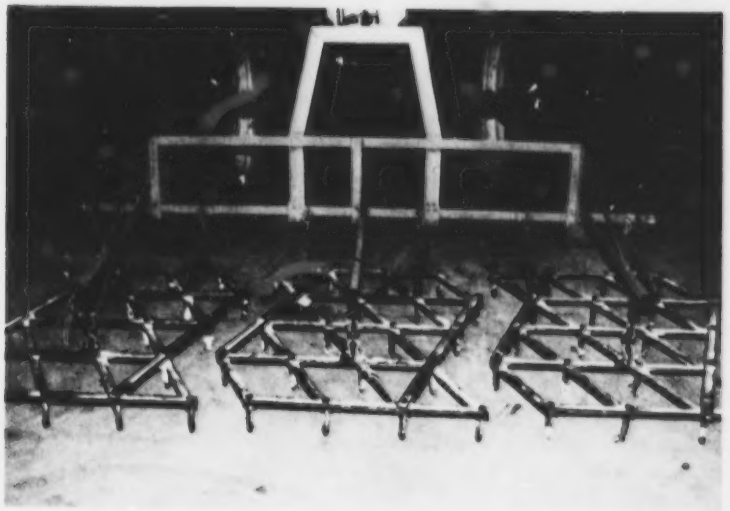
2) Mohawk Equipment Ltd.,
P.O. Box 103,
Ewert Ave.,
Brantford, Ontario
N3T 5M3

Telephone: (519) 753-3164

Fax: (519) 753-3166

**CURRENT USERS AND NUMBERS OF UNITS:**

| | |
|---|---|
| Chapleau | — |
| Dryden | 1 (Flex-Harrows) |
| Gogama | — |
| Kemptville | — |
| Midhurst | 2 (3-section) 1 (4-section) |
| Orono | 1 (3-section) |
| St. Williams | — |
| Swastika | — |
| Thessalon | — |
| Thunder Bay | 1 (4-section) |



Diamond-tooth harrows with three-point hitch — Midhurst Nursery.

## TECHNICAL INFORMATION

### SPECIFICATIONS:

**Inland Parallel Harrows**

Pass Width (Cut) -101 and 152 cm

Weight - 28 and 41 kg

Teeth/Section - 20 and 30

Current Price - $62.25 and $97.15/section

Inland drag harrows are constructed from 3.8 and 3.2 cm channel steel to provide weight and strength.

All drawhooks are fabricated from .8 cm steel.

The harrows teeth are forged from high carbon steel to improve wear resistance.

### OPTIONAL EQUIPMENT:

1) Harrow draw-bar - Inland will provide an optional steel draw-bar for use with up to six sections of diamond harrows. The unit is constructed from steel pipe. The draw-chains are attached to the bar by movable clamps that allow adjustments to suit different types and combinations of harrow sections.

### SPECIAL MODIFICATIONS:

The major modification noted was the conversion from the standard draw chain to a three-point hitch attachment.

## PRIME MOVER

### TYPE:

Standard agricultural tractor

### NET POWER REQUIREMENTS:

Minimum of 22.4 to 29.8 kw

### ATTACHMENT:

Standard draw-bar attachment

Three-point hitch with appropriate modifications

## TASK PERFORMED

Diamond-tooth harrows loosen and rake cull trees and debris following lifting operations. They are also used to level fields after ploughing and for summer fallowing and harrowing.

## HOW IT WORKS

### WORKING PRINCIPLE:

One or more harrow sections are attached to a horizontal draw-bar in a gang-type arrangement. The weight of each section places a downward force on the vertical teeth. As the sections are dragged along, the teeth work down into the top layer of the soil. The motion of the teeth passing through the soil causes a mixing action which breaks

up soil clods, and levels hummocks and depressions. The teeth also pick up field debris such as cull trees, weeds and sticks, which tend to become tangled in the teeth as the harrows pass over. The debris is cleared by lifting the individual harrow sections.

**GENERAL DESCRIPTION:**

A section of diamond-tooth harrows is normally constructed from heavy bar stock fabricated into a diagonal grating. At each intersection of the bar a threaded spike or tooth is placed through a hole drilled through at the intersection and bolted on with a heavy nut and washer.

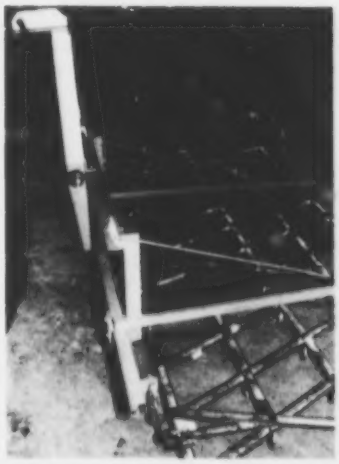
The teeth are forged from high-carbon steel to improve wear resistance against the heavily abrasive conditions under which the harrows must operate.

For nursery use, harrows sections are commonly arranged in gangs of three to four sections. Each section is attached to a draw-bar consisting of a steel pipe or bar via short lengths of chain. The draw-bar is connected to the tractor via a chain or cable arrangement to the draw-bar hitch or a hook mounted on the rear of the tractor.

To operate, the harrows gang is simply dragged around the field or compartment. When the tines become clogged with debris, the unit is dragged to the end of the compartment or to a nearby disposal area where each section is lifted to dislodge the debris.

Several of the nurseries that use diamond harrows have modified the standard hitching arrangement to incorporate a three-point hitch on the draw-bar. The modification facilitates the use of the hydraulic lifting capabilities of the three-point hitch for lifting an entire gang of diamond-tooth harrows for removal of debris and for transport. This reduces the major inconvenience of diamond-tooth harrows, which ordinarily requires each section of harrows to be lifted by hand to clear debris. This modification also makes it much easier to transport the unit along nursery roads and between nursery compartments.

The three-point hitch modification requires mounting two angled lifter bars to the draw-bar at an angle of 30 degrees. A horizontal lifter bar is welded across the ends of the angled lifter bars to provide attachment points for lifting chains. Each lifting chain is looped around the horizontal lifter bar and bolted to the rear of a section of harrows.



Close-up of mounting arrangement for diamond-tooth harrows with the three-point hitch modification.

**LIMITING FACTORS:**

1) Excessive cull or debris in the field may cause the harrows to clog quickly. This will necessitate frequent stops to clear the harrows and will quickly reduce effectiveness of the operation, particularly if the aim is simply to level the field.

2) Soil compaction will hinder the proper operation of the harrows. The individual sections do not have the weight or the strength to operate in heavily compacted soil.

## OPERATIONAL INFORMATION

**STAFF REQUIREMENTS:**

One person is required to drive the tractor.

**SAFETY ASPECTS:**

Normal safety precautions for use with agricultural machinery should be observed.

**MAINTENANCE:**

Diamond harrows require very little maintenance.

Replace worn or missing teeth.

Regularly inspect all chains and connections for excessive wear.

**Special maintenance equipment required** - None.

**Major repair items** - Harrows teeth.

**Ease of repair** - Very good. Parts are widely available from agricultural equipment suppliers. The simplicity of the construction also facilitates fabrication of most parts usually required.

**PRODUCTION RATES:**

A gang of four diamond harrows sections can level one hectare per hour. The actual production will depend on the amount of debris in the field. More debris will necessitate frequent stops to clear the harrows, which will decrease production.

The operating costs are approximately: $15 /Hr - tractor
$12 /Hr - operator

**USERS' ASSESSMENT**

Note: the following advantages and disadvantages relate primarily to the three-point hitch version of the diamond-tooth harrows. This modification greatly improves the operation of the diamond harrows and is strongly recommended.

**ADVANTAGES:**

1) Mobility. Because the harrows can be raised at any time manoeuvrability is greatly improved. Tight turns and manoeuvres can be made simply by raising the harrows momentarily.

2) Ease of clearing. By using the hydraulics to raise the harrows, the operator can clear debris from the harrows while remaining seated on the tractor. Without the three-point hitch modification, the operator would need to dismount the tractor and manually lift each section of harrows.

3) Extended life of the harrows teeth. Since the harrows no longer need to be dragged between nursery compartments or between the storage depot and the work area, the additional wear from packed or graveled road surfaces is eliminated.

**DISADVANTAGES:**

None noted.

**OPERATIONAL GROUP:**

**2** Ground Preparation

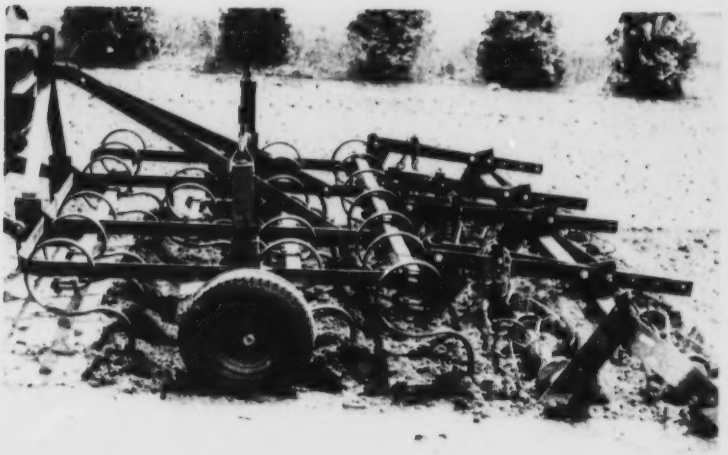
**EQUIPMENT TYPE:**

**2.05** Field Cultivators

**MAKES AND MODELS IN USE:**

1) International Harvester, McCormick 9
   450 Vibra-Shank
   4500
2) Kongskilde, Model 2115
3) Massey - Harris, Model N/A
4) McKee Woven Frame, Model 3 PH 2

Note: McKee Woven Frame and Massey - Harris Equipment is no longer available.



Kongskilde field cultivator with beater bar attachment — St. Williams Nursery.

**MANUFACTURERS AND DISTRIBUTORS:**

1) International Harvester now operated by J.I. Case Canada under the name Case - International.

   J.I. Case Canada,
   3350 South Service Road,
   Burlington, Ontario
   L7N 3M6

   Telephone: (416) 632-3800

   Distributors - Dealerships located across Ontario.

2) Kongskilde,
   P.O. Box 880,
   Exeter, Ontario
   N0M 1S0

   Telephone: (519) 235-0840

**CURRENT USERS AND NUMBER OF UNITS:**

| | | |
|---|---|---|
| Chapleau | 1 (iii) | |
| Dryden | - | |
| Gogama | 1 (iv) | |
| Kemptville | - | |
| Midhurst | 1 (i) | 1 (ii) |
| Orono | 1 (ii) | |
| St. Williams | 1 (ii) | |
| Swastika | 2 (i) | |
| Thessalon | - | |
| Thunder Bay | 1 (i) | |

Note: (i) Case-International (ii) Kongskilde (iii) Massey-Harris (iv) McKee Woven Frame

## TECHNICAL INFORMATION

### SPECIFICATIONS:

| | Kongskilde S - Series | Case International 4500 Series |
|---|---|---|
| Hitch Type | 3-point hitch and trailing | 3-point hitch |
| Shanks | 17 - 34 | 11 - 43 mounted<br>13 - 43 trailing |
| Shank Spacing | 10 - 15 cm | 15 - 25 cm |
| Gauge Wheels | 2 | 2 optional on mounted version |
| Rim Size | 40.6 cm | 35.6 cm |
| Frame | Pre-stressed steel | Stress-balanced, welded, tube steel |
| Clearance | 55.8 cm | 52.1 cm (from points to frame) |
| Working Width | 1.8 - 3.4 m | 2.6 - 5.6 m |
| Weight | 174.6 to 335.7 kg | N/A |

### OPTIONAL EQUIPMENT:

1) Bolt-on frame side extensions add more tines to the unit.

2) Front-mounted levelling bars.

3) Single and double rotary harrow attachments.

4) Trailing harrows with blade-type teeth and down-pressure stabilizing springs. (Kongskilde models.)

5) Finger harrow attachment.

Note: The above optional items are typical of those available for most field cultivators.

## PRIME MOVER

### TYPE:

Standard agricultural tractor

### NET POWER REQUIREMENT:

Minimum of 37.3 kw

### ATTACHMENT:

Three-point hitch and trailing versions available

## TASK PERFORMED

Field cultivators perform secondary tillage in the preparation of seedbed and planting bed surfaces.

## HOW IT WORKS

### WORKING PRINCIPLE:

A series of flexible spring-like tines gouge into the upper 7 to 18 cm of the soil surface. As the tines progress through the soil, their construction allows them to vibrate, thereby breaking up soil clods, while fluffing and mixing the soil-bed surface horizon.

Some field cultivators also incorporate rolling baskets that follow the cultivator tines to further break up and fluff the upper soil.

The cultivating and fluffing action loosens soil, removes small air pockets, and creates a uniform soil structure incorporating a firm base below the cultivated layer, a uniformly mixed cultivation layer, and a fine particulate layer along the surface. This structure ensures adequate soil contact with seeds and roots. It also improves the moisture retention qualities of the soil.

### GENERAL DESCRIPTION:

Field cultivators consist of a rigid steel frame to which a series of curved spring-like steel tines is mounted. The frame can be mounted to either the three-point hitch or the draw-bar of a standard agricultural tractor.

Larger units often incorporate hinged side extensions to the frame, which fold up to reduce the overall width for transport.

Gauge wheels, standard on trailing versions and optional on three point-hitch mounted cultivators, maintain a uniform operating depth across the width of the unit. On trailing versions the wheels also allow the unit to be raised to clear the ground for transport.

Cultivator tines are designed to flex and vibrate during operation. The shanks are generally constructed of hardened, spring steel. Like the chisels of the chisel plough the shanks are curved, with replaceable chisel points. On some makes the tines are fabricated with curving S-tine design, with each tine rigidly mounted to the frame. Other makes use curved tines and hinged frame mounts with heavy compression or tension-type springs.

In order to make the unit adaptable for different uses and soil conditions, a series of replaceable ground working tools and chisel points are normally available. Wearing of the shanks is also reduced because the replaceable tips are located at the point of maximum wear on each tine. When the points become worn or broken only the tips need to be replaced.

### LIMITING FACTORS:

1) The unit's construction makes it suitable only for secondary tillage. The frame and tines are not designed to handle the increased stress caused by the deeper operating depth in primary tillage.

## OPERATIONAL INFORMATION

### STAFF REQUIREMENTS:

One person is required to operate the tractor.

Close-up of the steel S-tines and the frame mounting arrangement.
Note: Collection of tree bundling elastics on tines.

Replacement tip on a field cultivator tine.

**SAFETY ASPECTS:**

Standard agricultural safety procedures are required.

**MAINTENANCE:**

No special maintenance is required. On units with hinged frames and greasable wheel bearings, regular greasing is recommended. Repair and/or replace tines and points with occasional mid-season repair or replacement as required.

**Special maintenance equipment required** - None.

**Major repair items** - Tine points.

Heavy duty replacement tines last approximately two seasons. (St. Williams Nursery)

**Ease of repair** - Very good.

Approximately two hours is required to replace 21 tine points on the Kongskilde Model 2115. (St. Williams Nursery)

**Parts availability** - Very good.

**PRODUCTION RATES:**

Approximately 1 ha/hour.

Note: Actual production rate will vary with the size of the unit. This figure is typical for the size of cultivators in use.

**USERS' ASSESSMENT**

**ADVANTAGES:**

1) The operating depth can easily be controlled to suit varying seedbed tillage requirements. Drag harrows, which are sometimes used for similar cultivation duties, have a fixed operating depth.

2) Light weight.

3) Ease of handling and minimal set-up allow the field cultivator to be mounted and put into use for quick and simple jobs such as loosening soil after a rain.

4) The field cultivator mixes and fluffs the bed surface more efficiently than a set of simple drag harrows.

**DISADVANTAGES:**

1) Limited operating depth. The frame and tines have not been designed for deep tillage applications for which a chisel plough would normally be used.

**OPERATIONAL GROUP:**

**2** Ground Preparation

**EQUIPMENT TYPE:**

**2.06** Path Cultivators

**MAKES AND MODELS IN USE:**

1) Badalini Multi Row Rototiller, MA/3ML

**MANUFACTURERS AND DISTRIBUTORS:**

1) Badalini S.p.A.,
Via Delmona 1,
46017 Rivarolo (MN),
Italy

Telephone: (0376) 99149-99324

Telex: 301576 BARIMA 1

Distributor: Timm Enterprises Ltd.,
5204 Trafalgar Road,
P.O. Box 157,
Oakville, Ontario
L6J 4Z5

Telephone: (416) 826-1333
(416) 878-4244

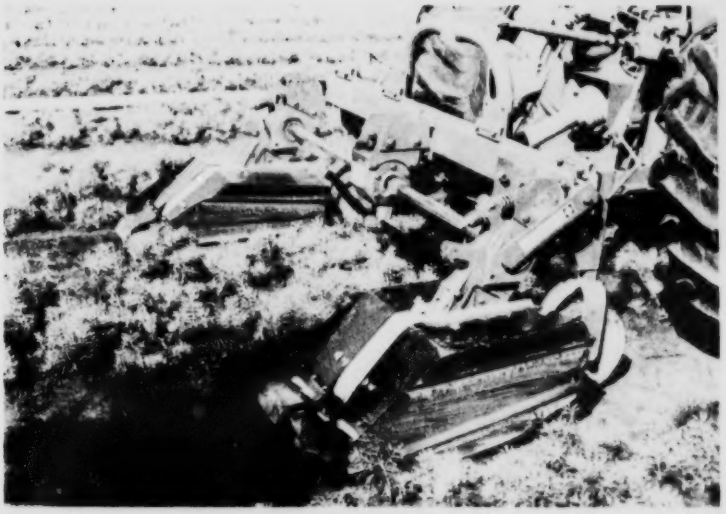
Telex: 06-982345

**CURRENT USERS AND NUMBER OF UNITS:**

| | | |
|---|---|---|
| Chapleau | - | |
| Dryden | 1 | * MNR |
| Gogama | 1 | * McKee |
| Kemptville | 1 | Badalini |
| Midhurst | 1 | * MNR |
| Orono | 2 | * MNR |
| St. Williams | - | |
| Swastika | 1 | Badalini |
| Thessalon | 1 | * MNR |
| Thunder Bay | - | |

* - Cultivators utilizing stationary tines.

Note: McKee models are no longer available.



Badalini multi row rototiller — Kemptville Nursery.

## TECHNICAL INFORMATION

### SPECIFICATIONS:

**Badalini**

| Model | MA/ | ME/ | MR/ | MG/ |
|---|---|---|---|---|
| Row Spacing (cm) | 30-90 | 45-100 | 40-90 | 60-150 |
| Path Width (cm) | 18-65 | 29-77 | 26-66 | 40-100 |
| Ground Clearance (cm) | 56 | 63 | 65 | 85 |
| Bar Lengths (cm) | 200-460 | 200-460 | 200-460 | 200-600 |
| Weight (kg) | 310-840 | 330-950 | 370-1050 | 830-2030 |
| Power Required (kw) | 15-52 | 22-75 | 37-89 | 52-89 |
| PTO rpm | 540/1000 | 540/1000 | 540/1000 | 540/1000 |
| Head Widths: (cm) | | | | |
| SS (Narrow) | 18-22 | N/A | 26-36 | 60-90 |
| ST (Standard) | 22-34 | 29-34 | 36-56 | 80-110 |
| ML (Medium Width) | 40-50 | 40-50 | N/A | N/A |
| L (Wide) | 54-65 | 51-62 | 46-66 | 100-150 |
| SL (Super Wide) | N/A | 67-77 | N/A | N/A |

Note: For details of the non-rotary path cultivators, direct all inquiries to the nurseries indicated.

### OPTIONAL EQUIPMENT:

1) Fertilizer spreader attachment Model SP/
   No. 3 150 kg spreader for machines with a 200-240 cm bar $2,357.00
   No. 4 200 kg spreader for machines with 300 to 320 cm bars $2,515.00
2) Ridging unit $264.00 - $545.00
3) Steering mechanism $1,235.00
4) 1000 RPM gear-box additional $269.50 if purchased with original unit
5) Additional rotors $105.00 - $490.00
6) Additional drum $123.00 - $209.00
7) Square shaft protection $269.50 - $337.00

### SPECIAL MODIFICATIONS:

1) Grease fittings installed on the shaft bearings and on the transmissions (Kemptville Nursery)

## PRIME MOVER

### TYPE:

Standard agricultural tractor.

### NET POWER REQUIREMENT:

The power required to operate a rotary path cultivator unit varies with the model, the number of tilling heads and the size of the heads. See manufacturer's suggested power requirements.

**ATTACHMENT:**

1) Three-point hitch, Category 1

2) P.T.O. capable of 540 rpm

**TASK PERFORMED:**

The path cultivator controls weeds in the pathways, loosens compacted soil and mixes peat into the soil.

**HOW IT WORKS**

**WORKING PRINCIPLE:**

A series of sharpened horizontal blades are passed through the upper soil horizons within the pathways. The blades loosen compacted soil and cut off the roots of any weeds growing within the pathways.

On rotary pathway cultivators, the blades are mounted on short revolving axles. The rotating tines provide more thorough soil mixing and break-up than stationary tines.

**GENERAL DESCRIPTION:**

Stationary tine path cultivators operate on the same basic principle as a typical agricultural field cultivator, except that the tines are grouped so that they only work the soil in the pathways between the beds. Rotary path cultivators use small adjustable rototiller heads.

Path cultivators with stationary tines are generally of a very simple design, fabricated by individual nurseries to meet their specific requirements. Typically a unit consists of a steel framework, which is mounted onto the three-point hitch of a tractor so that it can be raised and lowered as required. Two groups of standard field cultivator tines are spaced out on the frame so that as the tractor is driven along a seedbed the tines work the soil in the pathways on either side of the nursery-bed without interfering with the seedlings in the bed.

The passage of the stationary tines mixes the soil and loosens compaction. The roots of weeds within the pathways are cut off by the sharp horizontal portion of each tine.

The rotary tilling units of rotary path cultivators can be obtained with different operating widths and are often adjustable so that the head width can be fine-tuned to the width of the pathways. This type of cultivator is set up and operated in much the same fashion as the stationary tine version.

The operating depth is controlled by adjusting the three-point hitch and also by two depth control wheels mounted to the cultivator frame.

The tines on each tilling head are mounted on short rotating horizontal axles and powered through a shaft and transmission connected to the tractor PTO.

Each tilling head churns the soil within the pathway by the continuous rotating action of the blades. To prevent the churning soil from spilling out of the pathways onto the seedlings in the bed, each tilling head is enclosed in a metal shield.

**LIMITING FACTORS:**

1) Stony soil increases the wear on the tines and reduces their life span.

Close-up of an individual tilling head and the drive mechanism in operation.

2) Operates most effectively in dry soil conditions. If conditions are wet the soil becomes sticky and does not break up very well.

## OPERATIONAL INFORMATION

### STAFF REQUIREMENTS:

One person is required to drive the tractor.

### SAFETY ASPECTS:

The tractor must be shut down and the PTO placed out of gear before doing any adjustment or repair work on the rototiller units.

### MAINTENANCE:

The stationary tine version requires very little maintenance because its simple design involves few moving parts. Occasional inspection of the cultivating tines and shares for sign of damage or wear is sufficient. Occasional replacement of the shares will be required.

Rototiller type path cultivators are by nature more mechanically complex, requiring set maintenance procedures.

**Daily** - Inspect all blades and rotors for loose or missing mounting bolts. Straighten any blades that are bent.

- Lubricate the depth control wheels.

**Weekly** - Check the gearbox oil level.

**Seasonally** - At the end of the season repair or replace all worn or broken blades and lubricate joints.

**Major repair items** - The blades on the rototillers and the shares on the stationary tines.

Stony soils affect the frequency of repair and replacement.

Kemptville Nursery reported that they were forced to replace the bearings on the transmission of their Badalini Model MA/ 3ML. A leaking seal allowed the oil to escape, resulting in serious damage to the bearings. The original bearings were replaced with greasable bearings to avoid similar problems in the future.

**Ease of repair** - Very good.

**Special maintenance equipment required** - None.

**Parts Availability** - Very good.

### PRODUCTION RATES:

Rototiller version averages 3.1 km/hr.

Stationary tine version - N/A.

## USERS' ASSESSMENT

### ADVANTAGES:

1) Cheaper and more efficient than chemical weed control in the pathways between the nursery-beds.

2) The tractor-drawn path cultivator is much faster than hand-operated cultivators for weeding along rows of poplar. (Kemptville)

### DISADVANTAGES:

None noted.

**OPERATIONAL GROUP:**

**2** Ground Preparation

**EQUIPMENT TYPE :**

**2.07** Tractor-Mounted Rototillers

**MAKES AND MODELS IN USE:**

1) Gehring, Model GR76HD-R, Model GR84HD-R, Model GU60
2) Howard Rotovator, Model E
3) John Deere, Model 660
4) Kuhn, Model EL60

**MANUFACTURERS AND DISTRIBUTORS:**

1) Gehring Maschinenfabrik Ag,
CH-9548 Matzingen (Thurgau),
Switzerland

Telephone: 054-5313 63-64

Telex: 896 80

Distributor: Duke Lawn Equipment Ltd.,
1184 Plains Road East,
Burlington, Ontario
L7S 1W6

Telephone: (416) 637-5216 Burlington
(416) 827-7830 Toronto

Telex: 061-8858

2) Howard Rotovator Company Inc.,
343 South Division Street,
Harvard, Illinois
60033 U.S.A.

Distributor: I.Q. Company,
The Service Group,
R.R. 1,
Roblin, Ontario
K0K 2W0

Telephone: (613) 388-2222

3) John Deere Ltd.,
P.O. Box 1000,
Grimsby, Ontario
L3M 4H5

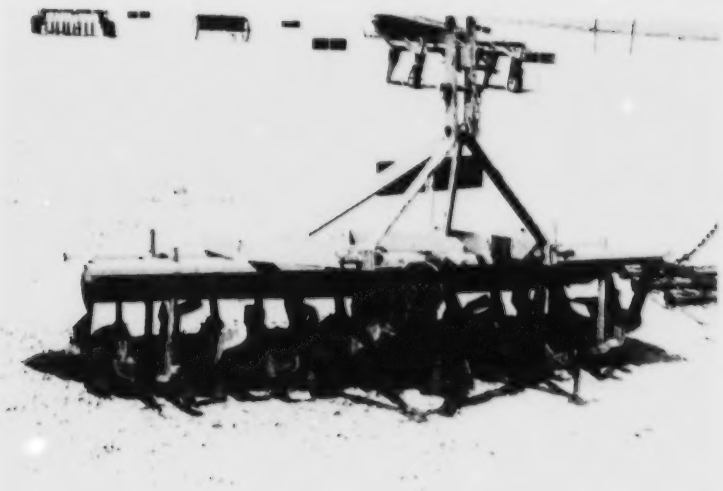
Telephone: (416) 925-9281

Distribution: Farm equipment dealerships located in most of the farming regions of Ontario.

4) Kuhn Farm Machinery Inc.,
P.O. Box 224,
Vernon, New York
13476 U.S.A.

Telephone: (315) 829-2620

Telex: 09 37456



Tractor-mounted rototiller — Dryden Nursery.

**CURRENT USERS AND NUMBER OF UNITS:**

| | | | | |
|---|---|---|---|---|
| Chapleau | - | | | |
| Dryden | 1 | GR84 | | |
| Gogama | 1 | KUHN EL60 | | |
| Kemptville | 1 | GR76HD-R | | |
| Midhurst | 1 | Howard | | |
| Orono | 1 | Howard | | |
| St. Williams | - | | | |
| Swastika | 1 | GR60 | 1 | John Deere 660 |
| Thessalon | - | | | |
| Thunder Bay | - | | | |

**TECHNICAL INFORMATION**

**SPECIFICATIONS:**

| | |
|---|---|
| Make | **Gehring** |
| Model | - GR68HD-R |
| | - Only Gehring model currently available |
| Tilling Width | - 1.73 m |
| Weight | - 372 kg |
| Number of Tines | - 32 |
| Tines | - L-shaped |
| Tine Speed | - 212 rpm at standard 540 rpm PTO speed |
| Tine Shaft | - Extra heavy duty<br>- Double row ball bearings with double interlocking seals |
| Frame | - Seamless welded steel tubing and high carbon steel plate<br>- Safety swivel feature in case the tiller impacts with a large object |
| Gearbox | - 52 - 56 kw rating.<br>- Double interlocking seals<br>- Relief value equipped to relieve excessive pressure and torque heat |
| Depth Adjustment | - Adjustable skids provide depth control from 3 - 25 cm |
| PTO | - Heavy-duty shaft<br>- Slip clutch PTO for tractors with low power rating |
| Bearings | - Heavy-duty ball and roller with double interlocking seals |

## PRIME MOVER

### TYPE:

Standard agricultural tractor.

### NET POWER REQUIREMENT:

33 - 37 KW.

### ATTACHMENT:

Category 1, three-point hitch.

## TASK PERFORMED

Three point hitch rototillers are used to till the soil before seeding and transplant operations.

## HOW IT WORKS

### GENERAL DESCRIPTION AND WORKING PRINCIPLE:

The dominant feature of a rototiller is the large tiller shaft and tines. The shaft is horizontal to the ground and perpendicular to the direction of travel.

Bearings at either end of the tilling shaft and on a centrally located transmission provide support for the shaft while allowing it to rotate. Power from the tractor PTO is transferred through a detachable shaft to the transmission and in turn to the tilling shaft and tines.

The tines are bolted to mounts staggered around the circumference, along the full length of the tiller shaft. The bolt mounts allow for easy replacement of worn or damaged tines, or for simple replacement with one of a variety of different styles available to suit different soil conditions and tilling requirements.

As the tiller shaft rotates, the tines are forced into the soil, chopping and mixing the soil. The intensive churning action of the rotating tines is very effective at loosening compaction and mixing the soil in a nursery-bed. A thorough tilling of a nursery-bed can usually be accomplished in a single pass.

The maximum tilling depth for a rotary tiller is determined by the length of the tines. Operating depths are controlled by adjusting the three-point hitch and also by two height-adjustable skids.

### LIMITING FACTORS:

1) When the soil is wet it tends to clump on the tines and is not loosened as effectively as with dry soil.

## OPERATIONAL INFORMATION

### STAFF REQUIREMENTS:

One person is required to drive the tractor.

### SAFETY ASPECTS:

All personnel should remain clear of the PTO shaft and the tines when the unit is in operation.

Before commencing any maintenance work, the tractor should be stopped and the PTO placed out of gear.

**MAINTENANCE:**

**Daily** - Grease the PTO shaft.

**Weekly** - Check oil level in the gearbox.
- Top up oil as required.

**Seasonal** - Thoroughly inspect tines for wear and damage annually.

**Special maintenance equipment required** - None.

**Major repair items** - On average the tines must be replaced once every two to three years.

**Ease of repair** - Very good. All parts are easily accessible.

**Parts availability** - Very good.

**USER'S ASSESSMENT**

**ADVANTAGES:**

1) Use of a tractor-mounted rototiller saves time and manpower. In most cases a single pass of the implement is sufficient to adequately loosen compaction and break up soil clods in preparation for seeding and transplant operations.

**DISADVANTAGES:**

1) Repeated use of the unit tends to break down the soil particle size.

**OPERATIONAL GROUP**

**2** Ground Preparation

**EQUIPMENT TYPE:**

**2.08** Rock Rake

**MAKES AND MODELS IN USE:**

1) Degelman, Model LC 1400

**MANUFACTURERS AND DISTRIBUTORS:**

1) Degelman Industries Ltd.,
P.O. Box 830,
480 Industrial Drive,
Regina, Saskatchewan
S4P 3B1

Telephone: (306) 543-4447

Telex: 071-2747

Distributor: Eastern Farm Supply Ltd.,
340 Edinburgh Road,
Guelph, Ontario
N1H 1E1

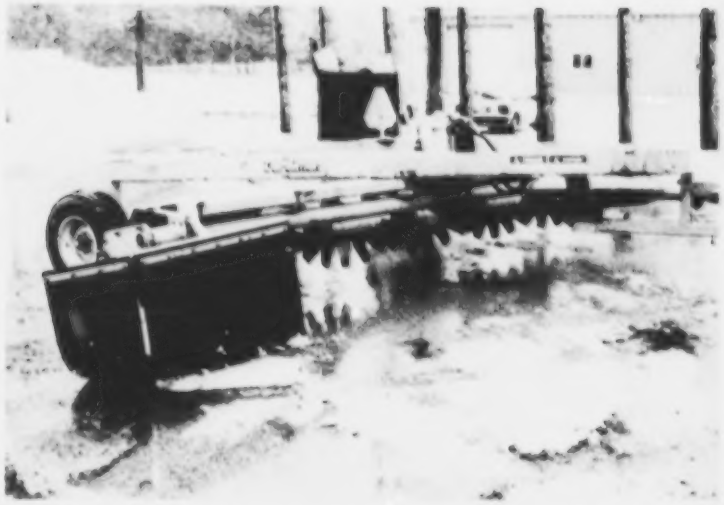
Telephone: (519) 836-2400

**CURRENT USERS AND NUMBER OF UNITS:**

| | |
|---|---|
| Chapleau | — |
| Dryden | — |
| Gogama | — |
| Kemptville | — |
| Midhurst | 1 |
| Orono | — |
| St. Williams | — |
| Swastika | — |
| Thessalon | — |
| Thunder Bay | — |

**PRICE OF CURRENT MODELS:**

Model LC1400 $8,553.00



Degelman rock rake — Midhurst Nursery.

## TECHNICAL INFORMATION

### SPECIFICATIONS:

| | |
|---|---|
| Model | **LC 1400** |
| Hydraulics | - One 123 mm remote hydraulic cylinder (not supplied) |
| PTO Drive | - 540 rpm standard, 1000 rpm optional |
| Drum Speed | - 90 -135 rpm |
| Weight | - 1455 kg |
| Width | - 4.27 M |
| Tires | - 9.5L x 15-6 ply |

### COMPLEMENTARY EQUIPMENT:

1) Rock Pickers. These units are usually designed to trail behind an agricultural tractor. In a secondary operation following raking, the rock picker is towed along the windrows of rocks left by the rake. The rocks are gathered by a sloping conveyor that lifts the rocks and debris into a transport bin on the rear of the picker.

2) Stone Forks. (See section 2.09) Once rocks and debris have been windrowed, a stone fork may be used to lift the windrows of rocks into a truck or to a rock disposal pile next to the nursery field. The stone fork is similar to a heavy duty hay fork that attaches to a fork-lift tractor or to the hydraulic three-point hitch on a standard agricultural tractor.

## PRIME MOVER

### TYPE:

Standard agricultural tractor with hydraulics.

### NET POWER REQUIREMENT:

Minimum of 30 kw.

### ATTACHMENT:

Clevis attachment to the tractor draw-bar.

Note: The clevis is adjustable to allow the frame of the rock-rake to be levelled.

## TASK PERFORMED

The rock rake was designed to windrow small to medium-sized rocks and other debris during land clearing. Field debris can interfere with nursery operations such as transplanting and in general tends to increase equipment wear and breakage.

The unit also assists in breaking up soil clods and provides a limited degree of soil cultivation.

Summary of Equipment Settings vs Conditions

| Rock Density | Average Size | Rake Angle (Deg.) | Drum Speed | Travel |
|---|---|---|---|---|
| Mild | Small | 22 | Faster | Faster |
| | Medium | 18-22 | Normal | Faster |
| | Large | 22 | Slower | Faster |
| Medium | Small | 18-22 | Faster | Normal |
| | Medium | 18-22 | Normal | Normal |
| | Large | 22 | Slower | Normal |
| Heavy | Small | 18-22 | Normal | Slower |
| | Medium | 18-22 | Slower | Slower |
| | Large | 22 | Slower | Slower |

Note: Small rocks - 4 to 9 cm in diameter

Medium rocks - 10 to 18 cm in diameter

Large rocks - 19 to 26 inches in diameter

Travel speed average between 3 and 10 kph.

Drum Angle vs Uses

| Drum Angle | Typical Use |
|---|---|
| 14 Degrees | Light rototilling action and soil lump break-up |
| 18 " | Raking of medium to large rocks or medium to heavy field density |
| 22 " | Raking of medium to small rocks with rapid augering action |

Rocks 29 cm or more should be manually lifted from the field to prevent damage to the rake teeth.

**LIMITING FACTORS:**

1) Stones less than 9 cm in diameter tend to pass through the tines.

2) The unit operates most efficiently when the soil is dry.

**OPERATIONAL INFORMATION**

**STAFF REQUIREMENTS:**

One person is required to drive the tractor and operate the hydraulic controls.

**SAFETY ASPECTS:**

1) All personnel should be kept clear of the rock rake while it is in operation.

2) All power train and drive shaft shields should be left in place at all times.

3) Before adjusting, lubricating, or servicing the rake ensure that the tractor engine is off and that the spiral drum assembly is lowered to the ground. Never work under the spiral drum when it is in the raised position. Keep hands and feet well away in case the assembly drops unexpectedly.

4) Always block the frame before adjusting the wheel height.

**MAINTENANCE:**

The unit has been in use at the M' dhurst Tree Nursery for four years without major breakdowns.

The following is a summary of the manufacturer's recommended maintenance for the Degelman Rock Rake Model LC 1400.

**Daily** - Inspect hydraulic system for signs of fluid leaks.
- Check tire air pressure.

**Weekly** - Drive train:
- Inspect and lubricate all bearings.
- Check coupling set screws.
- Check all sprocket set screws.
- Adjust for proper chain tension.
- Clean chain housing.
- Check the tightness of all drum tines.
- Check gear box oil level.

**Pre-season:** - Inspect for hydraulic fluid leaks.
- Drive train:
- All items listed under weekly maintenance of the drive train.
- Inspect all bolts and nuts for proper tightness.
- Align sprocket properly.
- Check the tightness of all structural nuts and bolts.
- Check tire air pressure.
- Ensure that all wheel rim nuts are tight.
- Check gear box oil level.

**Post-Season:** - Inspect for any hydraulic fluid leaks.
- Drive train:
- Inspect bearing condition.
- Inspect coupling set screws.
- Inspect for proper sprocket alignment.
- Adjust for proper chain tension.
- Clean chain housing.

**Special maintenance equipment required** - None.

**Major repair items** - Worn tines. The hardened steel tines must be replaced once every two years. After the first year of use they are reversed to extend their lifespan.

**Ease of repair** - Very good. Generally all parts of the rake are accessible. Reversing or replacing tines requires the removal of two bolts on each tine.

**Parts availability** - Very good.

## HOW IT WORKS

### WORKING PRINCIPLE:

A wide, horizontal, toothed drum, suspended on a wheeled frame, is pulled along the nursery field. As the drum rotates the teeth brush through the upper few centimetres of soil in a direction opposite to the forward travel of the unit. Stones and other small to medium-size debris are kicked forward by the revolving teeth. The forward motion of the tractor, the kicking action of the teeth and the angle of the drum shuffle the debris towards the right side of the unit. A rubber deflector channels all debris into a windrow.

### GENERAL DESCRIPTION:

The frame of the rock rake is constructed of heavy welded steel. On the front end it narrows to a tongue and an adjustable clevis. The clevis mount is adjustable in order to allow the frame to be oriented parallel to the ground, a requirement for proper operation.

Two heavy vertical posts extending down from the rear corners of the frame serve as mounting posts for the wheels. The frame operating height is set by adjusting the wheel mounts.

The rocks are raked by the spiral drum assembly. The spiral drum is a long, narrow, rotating cylinder with hardened steel teeth bolted to its surface in a spiral arrangement. The drum is suspended at each end by heavy duty sealed ball bearings on arms extending down and back from a horizontal member of the frame called the rock shaft. The rock shaft is mounted by three bearings and extends across the width of the frame. A hydraulically operated cylinder pushes or pulls on an arm welded to the centre section of the rock shaft so that the shaft can be pivoted thereby raising and lowering the spiral drum.

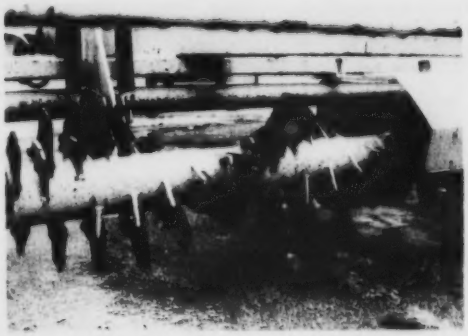
For protection the drum assembly features a floating action that allows it to ride over immobile obstructions without lifting the entire unit or causing damage to the drum and raking teeth. Two heavy steel springs, mounted to an arm attached to the opposite side of the rock shaft from the hydraulic pivoting assembly, allow the drum to momentarily trip and reset upon encountering a large solid object or hummock.

During field operation the rake is set up so that the teeth penetrate approximately 2 cm into the soil surface. This depth provides for optimum raking action while reducing unnecessary wear on the teeth.

The angle of the spiral drum with respect to the direction of travel, the rotational speed of the drum, and the forward travel speed of the unit combine to determine how the rake will function.

The proper rake angle is selected according to field conditions and the desired results. On the LC 1400 the angle is set by loosening the bolts that tighten the clamp holding the drum and rock-shaft assembly to the main frame. The assembly can be swivelled from 10 to 30 degrees perpendicular to the direction of travel.

The rotational speed of the drum is determined by the speed of the tractor PTO drive. In normal operation the tractor engine should be adjusted for a PTO speed of 540 rpm or 1000 rpm. After passing through the transmission and roller chain drive the rotational speed is reduced, so that the drum revolves at a 143 and 176 rpm at a PTO speed of 540 and 1000 rpm respectively.



Spiral drum assembly.

**PRODUCTION RATES:**

During operation the rock rake operates at between 3 and 10 km/hour. The unit is usually operated at an average speed of 3 km/hour at Midhurst Nursery.

The unit will typically make approximately 0.4 ha/hour under normal operating conditions.

**USERS' ASSESSMENT**

**ADVANTAGES:**

1) There is a considerable saving in labour over manual rock picking.

2) The rock rake does a much better job than manual rock picking. Fields tend to be much cleaner.

3) The rock rake assists in breaking up soil clods.

**DISADVANTAGES:**

1) The unit only affects the surface rocks. Rocks more than 6 cm below the surface are not touched and therefore may still interfere with other nursery equipment.

2) Rocks that are partially buried or slightly below the reach of the tines are often packed further into the soil as the rock rake passes over them.

3) A second operation is required to remove the windrows of rocks and debris from the field. The second operation may take the form of manual forking into trucks, forking with a tractor, or lifting of the windrows with a rock picker.

**OPERATIONAL GROUP:**

**2** Ground Preparation

**EQUIPMENT TYPE:**

**2.09** Stone Fork

**MAKES AND MODELS IN USE:**

1) Kverneland, Stone Fork

Distributor: NorCan Farm Equipment Ltd.,
P.O. Box 1237,
Cambridge, Ontario
N1R 6C9

Telephone: (519) 623-8261

Kverneland stone fork — Midhurst Nursery.

**CURRENT USERS AND NUMBER OF UNITS:**

| | |
|---|---|
| Chapleau | - |
| Dryden | - |
| Gogama | - |
| Kemptville | - |
| Midhurst | 1 |
| Orono | - |
| St. Williams | - |
| Swastika | - |
| Thessalon | - |
| Thunder Bay | - |

**PRICE OF CURRENT MODELS:**

| | |
|---|---|
| 19-Tine | $1,905.00 |
| 25-Tine | $2,535.00 |

**TECHNICAL INFORMATION**

**SPECIFICATIONS:**

| | |
|---|---|
| Width | - 152 / 200 cm |
| Height | - 69 cm |
| Height of Sides | - 25 cm |
| Number of Tines | - 19 / 25 |
| Tine Length | - 86 cm |
| Tine Construction | - solid hardened steel<br>- tapering from 5 cm to 2.5 cm at tip |
| Distance Between Tines | - 7 / 10 cm |
| Weight | - 201 / 240 kg |

**OPTIONAL EQUIPMENT:**

1) Hydraulic ram with single or double action for category one two point hitches.

**SPECIAL MODIFICATIONS:**

The standard unit comes equipped with three-point hitch attachment points.

To improve the convenience and flexibility of the unit when gathering windrows of stones, the unit has been fitted with mounts for attachment to a front-end loader assembly. This modification allows the fork to be lifted high enough to dump the rocks into a truck for hauling. (Midhurst Nursery)

**COMPLEMENTARY EQUIPMENT:**

1) The unit is used in conjunction with a Degelman Rock Rake. (See Section 2.08)

2) A truck (5-ton) is used to haul rocks to the dumping site.

**PRIME MOVER**

**TYPE:**

Standard agricultural tractor equipped with a fork lift attachment. Alternatively, a tractor with a hydraulic three-point hitch will suffice if the additional lifting capabilities and flexibility are not required.

**NET POWER REQUIREMENT:**

A minimum of 22 kw.

**ATTACHMENT:**

A hydraulic three-point hitch.

With the modifications mentioned above the tractor will require a front-end loader assembly.

**TASK PERFORMED**

The stone fork is used to pick up the windrows of rocks and debris left by rock raking. The fork scoops up the windrowed debris, allowing it to be dumped into a haul truck or carried to a rock dump area.

The unit can also be used effectively to gather windrowed cull trees from nursery fields.

**HOW IT WORKS**

**GENERAL DESCRIPTION AND WORKING PRINCIPLE:**

The stone fork has the same basic configuration as a standard multi-tined hay fork. Straight horizontal steel tines extend out from a vertically oriented rectangular steel frame, which mounts directly to the three-point hitch or the fork lift attachment of the tractor.

During operation, the fork is tilted slightly so that the tips of the tines extend approximately 3 to 8 cm into the soil surface, at a shallow angle. The unit moves forward along the rock windrows to gather the rocks, stones, and debris. The rocks in the windrow slide up on the tines of the fork and pile up against the rear steel frame of the fork. Any soil

picked up with the rocks sifts between the tines of the fork back to the soil surface.

When the fork has a full load it is hydraulically tilted so that the tines tip upwards. This prevents the rocks from falling off the fork. The loaded fork is lifted and dumped into a nearby truck or taken to be dumped at a nearby rock disposal site.

**LIMITING FACTORS:**

1) The unit was designed for scooping up surface rocks and debris. Digging rocks out of the soil with a stone fork will tend to bend and break the tines.

During operation the tines should be lowered no more than 8 cm into the soil to prevent unnecessary strain on the tines and the loader assembly.

2) If field conditions are too wet the soil will not sift properly through the tines, causing some soil to be scooped up with the rocks.

3) An experienced operator is required to maintain the tines at the correct depth and prevent equipment damage.

**OPERATIONAL INFORMATION**

**STAFF REQUIREMENTS:**

**Operator** - One person is required to operate the tractor and loader attachments.

**Support** - Two people are required to manually fork any stray rocks from either side of the windrow into the stone fork.
- One driver is required for the haul truck.

**SAFETY ASPECT:**

Standard safety practices for use of agricultural machinery should be observed.

Personnel should remain clear of the forks, particularly when the loaded forks are being raised.

**MAINTENANCE:**

**Daily** - Grease fittings on the hitch pins before each use.

**Other** - Inspect tines regularly and replace as required.

**Special maintenance equipment required** - None.

**Major repair items** - The unit at Midhurst Nursery has been in use for a single season. No major maintenance has been required yet. Occasional replacement of the tines is expected.

**Ease of repair** - Very good. Tine replacement is simply a matter of unbolting the old tines and bolting in the replacement tine.

**Parts availability** - Very good.

## USERS' ASSESSMENT

### ADVANTAGES:

1) The stone fork allows soil to sift through the tines back to the soil surface. A straight tractor bucket cannot scoop up rocks from the soil surface without also scooping up soil.

2) The stone fork picks up the surface rocks directly with a minimum amount of manual labour. The fork requires only two pickers to retrieve stray rocks. A straight bucket requires four pickers to manually load the rocks into the bucket.

3) The combination of rock rake and stone fork is much faster than rock picking with manual labour and a bucket loader.

### DISADVANTAGES:

1) When labour is easily available and cheap, manual picking may be more cost-effective than the rock rake stone fork combination.

2) If labour is very tight, a rock picking machine may be more cost-effective. With a rock rake and rock picking machine combination, only one person and tractor need be involved in rock removal. One person could first rake the field, then, using a rock picker, gather the windrows and haul them to the dump site.

**OPERATIONAL GROUP**

**2** Ground Preparation

**EQUIPMENT TYPE:**

**2.10** Subsoilers

**MAKES AND MODELS IN USE:**

1) John Deere, 23B Tool-bar with two subsoiling shanks
2) Taylor-Way, Model 100012, Three-shank subsoiler
   Model 01109, Three-shank subsoiler

**MANUFACTURERS AND DISTRIBUTORS:**

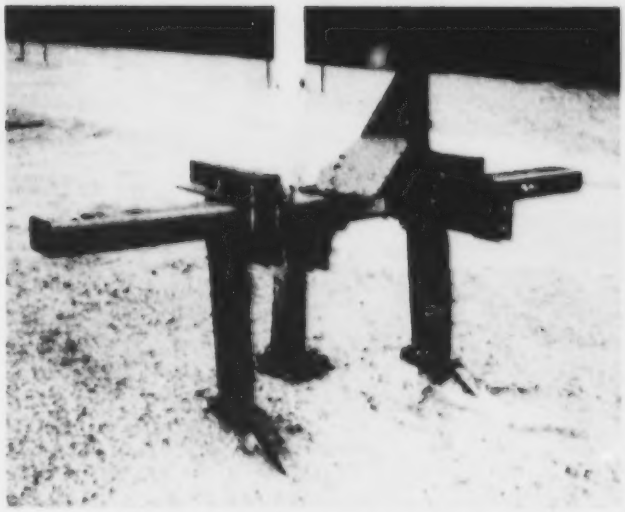
1) John Deere Ltd.,
   P.O. Box 1000,
   Grimsby, Ontario
   L3M 4H5

   Telephone: (416) 945-9281

   Distributors: Dealerships located throughout Ontario.

2) Taylor-Way Implement Division,
   Pittsburgh Forgings Company,
   Athens, Tennessee
   37303 U.S.A.

   Telephone: (615) 745-3110



Two-shank subsoiler — Dryden Nursery.

**CURRENT USERS AND NUMBER OF UNITS:**

| | |
|---|---|
| Chapleau | - |
| Dryden | 2 * |
| Gogama | 1 *** |
| Kemptville | 1 ** |
| Midhurst | - |
| Orono | 1 |
| St. Williams | - |
| Swastika | 1 ** |
| Thessalon | - |
| Thunder Bay | 1 * |

Note: * John Deere ** Taylor-Way *** MNR Fabricated

**TECHNICAL INFORMATION**

**SPECIFICATIONS:**

**1) John Deere: Model 23B**

| | |
|---|---|
| Tool Bar Size | - 10.2 x 17.8 x 240.0 cm |
| Tool bar | - Heavy-duty tube steel |
| Hitch | - Category 2, Three-point hitch |
| Weight | - N/A |
| Number of Shanks | - 2 - 3 |
| Shank Shear Bolts | - 1.375 x 7.7 cm (SAE 2) bolt |
| Shank Size | - 3.2 x 10.2 cm cross-section |

| | |
|---|---|
| Wear Plates | - Replaceable. Fit along front edge of the subsoiling shank to prevent wear |
| Subsoiler Points | - Replaceable |
| | - Heat-treated |
| Maximum Operating depth | - 40.6 cm |

**2) Taylor-Way: Model 100012**

| | |
|---|---|
| Tool Bar Size | - 2.7 x 20.3 x 246.4 cm |
| Tool Bar | - Welded boxed angle steel |
| Hitch | - Category 2, Three-point hitch |
| | - 2.86 cm link pins |
| Weight | - 487.6 kg |
| Number of Shanks | - 2 - 3 |
| Shank Shear Bolt | - 1.91 cm |
| Shank Size | - 2.5 x 20.3 cross-section |
| Wear Plates | - replaceable and reversible to prevent wearing along the front edge of the shanks |
| Subsoiler Points | - Drop-forged |
| | - Heat-treated |
| | - Replaceable |
| Maximum Shank Spacing | - 101.6 cm |
| Maximum Operating Depth | - 56 cm |

**OPTIONAL EQUIPMENT:**

1) Adjustable and non-adjustable depth shanks. (John Deere)
2) Replaceable hardened steel protectors mounted to the front vertical edges of the subsoiler shanks, which minimize wear on the shanks, thereby extending their life.
3) Stands for additional support when the device is not in use.
4) Depth-gauge wheel attachment.
5) Mole attachment for shank. (Taylor-Way)
6) Open-foot lister and chisel. (John Deere)
7) Friction trip shanks. (John Deere)
8) Safety trip shank. (John Deere)
9) Subsurface sweep. (John Deere)
10) Various tool-bar clamps and spacers. (John Deere)
11) Border disc maker. (John Deere)

Note: Options are available for both makes unless otherwise stated.

**PRIME MOVER**

**TYPE:**

Standard agricultural tractor.

**NET POWER REQUIREMENT:**

Minimum of 48 kw for a two shank subsoiler.

Suggested Power - 78 kw Dead Break for a 3 shank subsoiler.
- 67 kw Dead Break for the 2 shank version.

**ATTACHMENT:**

Three-point hitch.

## TASK PERFORMED

Subsoilers are used to breakup hardpan and to aerate the soil below the plough layer.

Subsoilers also tend to lift rocks to the surface.

## HOW IT WORKS

**GENERAL DESCRIPTION AND WORKING PRINCIPLE:**

The basic subsoiler design incorporates as a main frame a heavy horizontal steel tube or bar mounted to the three-point hitch of an agricultural tractor.

One or more narrow steel shanks extend downwards from the bar into the soil. Each shank has a replaceable subsoiling point at its base of wide, angled, hardened steel. During operation the strong steel shanks provide rigid support to counteract the large frictional drag caused by the working points.

As the subsoiler is pulled forward by the tractor, the narrow vertical shanks slice through the upper soil horizon with minimal soil disturbance. The points operating 45 to 60 cm below the soil surface force the soil at that depth to lift and separate as they pass through the soil. The lifting and separating action breaks-up hardpan and other restrictive layers below the plough zone.

Operating depth is primarily determined by the setting of the hydraulic three-point hitch. The attachment points on the subsoiler frame are changed for optimum operation.

**LIMITING FACTORS:**

1) The number of shanks affect the amount of time required to subsoil a given land area. With more teeth mounted on the subsoiler bar, the operation will be proportionally faster.

2) The power rating of the tractor determines the maximum number of teeth that can safely and efficiently be used. Each additional tooth requires a considerable increase in power to operate.

3) The proper set-up and adjustment of the unit is very important for maintaining the efficiency of the operation of the unit and for ensuring minimum wear.

## OPERATIONAL INFORMATION

**STAFF REQUIREMENTS:**

One person is required to drive the tractor.

**SAFETY ASPECTS:**

1) Tractor front-end weights should be used according to the manufacturer's suggestions to improve tractor stability and safety. When operating the tractor in lower gear at speed below 6.5 km/h, the maximum front end weighting allowable is required to prevent the front end from tipping up.

2) The subsoiler should be firmly placed on supports prior to unhitching the unit from the tractor.

3) If the unit is operated too quickly, the front end of the tractor may have a tendency to jump up on encountering any rock or an area of heavily compacted soil.

**MAINTENANCE:**

**Daily** - Before each use check bolts, set screws and cotter pins to ensure they are tight and in good condition.

**Other** - Pre-season servicing includes a thorough cleaning, and inspection. All nuts and bolts should be tightened.

- Occasionally all nuts and bolts should be tightened to the torques suggested in the owner's manual.

- Post-season servicing. To prevent rust and corrosion during winter storage:

- Clean the unit thoroughly.

- Apply rust preventing substance to all exposed metallic surfaces.

**Special maintenance equipment required** - None.

**Major repair items** - The shank points require replacement approximately once a season.

**Ease of Repair** - Very good.

**Parts availability** - Very good. Models currently in use are made by large reputable manufacturers with good parts supplies.

**PRODUCTION RATES:**

A single shank subsoiler operating at 30 cm spacing can subsoil approximately 1.5 hectares in eight hours.

A dual shank unit can subsoil approximately 3 hectares in eight hours.

**USERS' ASSESSMENT**

**ADVANTAGES:**

1) The design of the subsoiler enables it to operate at a greater depth than regular plough type implements.

2) The subsoiler breaks up compaction layers deep in the soil while causing a minimum of mixing in the plough zone.

3) Provides a cost-effective means of improving drainage if tiles are not installed.

4) Unlike standard mouldboard ploughs relatively few adjustments are required.

**DISADVANTAGES:**

None were noted.

**OPERATIONAL GROUP**

**2** Ground Preparation

**EQUIPMENT TYPE:**

**2.10** Subsoilers

**MAKES AND MODELS IN USE:**

1) John Deere, 23B Tool-bar with two subsoiling shanks
2) Taylor-Way, Model 100012, Three-shank subsoiler
   Model 01109, Three-shank subsoiler

**MANUFACTURERS AND DISTRIBUTORS:**

1) John Deere Ltd.,
   P.O. Box 1000,
   Grimsby, Ontario
   L3M 4H5

   Telephone: (416) 945-9281

   Distributors: Dealerships located throughout Ontario.

2) Taylor-Way Implement Division,
   Pittsburgh Forgings Company,
   Athens, Tennessee
   37303 U.S.A.

   Telephone: (615) 745-3110

**CURRENT USERS AND NUMBER OF UNITS:**

| | |
|---|---|
| Chapleau | - |
| Dryden | 2 * |
| Gogama | 1 *** |
| Kemptville | 1 ** |
| Midhurst | - |
| Orono | 1 |
| St. Williams | - |
| Swastika | 1 ** |
| Thessalon | - |
| Thunder Bay | 1 * |

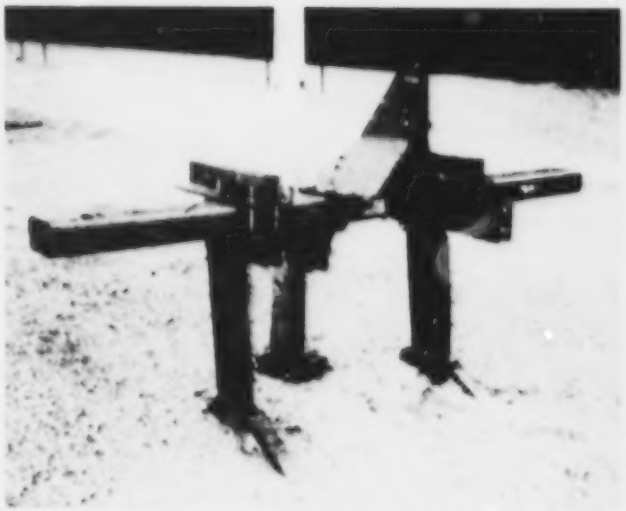
Note: * John Deere ** Taylor-Way *** MNR Fabricated

**TECHNICAL INFORMATION**

**SPECIFICATIONS:**

**1) John Deere: Model 23B**

| | |
|---|---|
| Tool Bar Size | - 10.2 x 17.8 x 240.0 cm |
| Tool bar | - Heavy-duty tube steel |
| Hitch | - Category 2, Three-point hitch |
| Weight | - N/A |
| Number of Shanks | - 2 - 3 |
| Shank Shear Bolts | - 1.375 x 7.7 cm (SAE 2) bolt |
| Shank Size | - 3.2 x 10.2 cm cross-section |



Two-shank subsoiler — Dryden Nursery.

| | |
|---|---|
| Wear Plates | - Replaceable. Fit along front edge of the subsoiling shank to prevent wear |
| Subsoiler Points | - Replaceable |
| | - Heat-treated |
| Maximum Operating depth | - 40.6 cm |

**2) Taylor-Way: Model 100012**

| | |
|---|---|
| Tool Bar Size | - 2.7 x 20.3 x 246.4 cm |
| Tool Bar | - Welded boxed angle steel |
| Hitch | - Category 2, Three-point hitch |
| | - 2.86 cm link pins |
| Weight | - 487.6 kg |
| Number of Shanks | - 2 - 3 |
| Shank Shear Bolt | - 1.91 cm |
| Shank Size | - 2.5 x 20.3 cross-section |
| Wear Plates | - replaceable and reversible to prevent wearing along the front edge of the shanks |
| Subsoiler Points | - Drop-forged |
| | - Heat-treated |
| | - Replaceable |
| Maximum Shank Spacing | - 101.6 cm |
| Maximum Operating Depth | - 56 cm |

**OPTIONAL EQUIPMENT:**

1) Adjustable and non-adjustable depth shanks. (John Deere)

2) Replaceable hardened steel protectors mounted to the front vertical edges of the subsoiler shanks, which minimize wear on the shanks, thereby extending their life.

3) Stands for additional support when the device is not in use.

4) Depth-gauge wheel attachment.

5) Mole attachment for shank. (Taylor-Way)

6) Open-foot lister and chisel. (John Deere)

7) Friction trip shanks. (John Deere)

8) Safety trip shank. (John Deere)

9) Subsurface sweep. (John Deere)

10) Various tool-bar clamps and spacers. (John Deere)

11) Border disc maker. (John Deere)

Note: Options are available for both makes unless otherwise stated.

**PRIME MOVER**

**TYPE:**

Standard agricultural tractor.

**NET POWER REQUIREMENT:**

Minimum of 48 kw for a two shank subsoiler.

Suggested Power - 78 kw Dead Break for a 3 shank subsoiler.
- 67 kw Dead Break for the 2 shank version.

**ATTACHMENT:**

Three-point hitch.

## TASK PERFORMED

Subsoilers are used to breakup hardpan and to aerate the soil below the plough layer.

Subsoilers also tend to lift rocks to the surface.

## HOW IT WORKS

**GENERAL DESCRIPTION AND WORKING PRINCIPLE:**

The basic subsoiler design incorporates as a main frame a heavy horizontal steel tube or bar mounted to the three-point hitch of an agricultural tractor.

One or more narrow steel shanks extend downwards from the bar into the soil. Each shank has a replaceable subsoiling point at its base of wide, angled, hardened steel. During operation the strong steel shanks provide rigid support to counteract the large frictional drag caused by the working points.

As the subsoiler is pulled forward by the tractor, the narrow vertical shanks slice through the upper soil horizon with minimal soil disturbance. The points operating 45 to 60 cm below the soil surface force the soil at that depth to lift and separate as they pass through the soil. The lifting and separating action breaks-up hardpan and other restrictive layers below the plough zone.

Operating depth is primarily determined by the setting of the hydraulic three-point hitch. The attachment points on the subsoiler frame are changed for optimum operation.

**LIMITING FACTORS:**

1) The number of shanks affect the amount of time required to subsoil a given land area. With more teeth mounted on the subsoiler bar, the operation will be proportionally faster.

2) The power rating of the tractor determines the maximum number of teeth that can safely and efficiently be used. Each additional tooth requires a considerable increase in power to operate.

3) The proper set-up and adjustment of the unit is very important for maintaining the efficiency of the operation of the unit and for ensuring minimum wear.

## OPERATIONAL INFORMATION

**STAFF REQUIREMENTS:**

One person is required to drive the tractor.

**SAFETY ASPECTS:**

1) Tractor front-end weights should be used according to the manufacturer's suggestions to improve tractor stability and safety. When operating the tractor in lower gear at speed below 6.5 km/h, the maximum front end weighting allowable is required to prevent the front end from tipping up.

2) The subsoiler should be firmly placed on supports prior to unhitching the unit from the tractor.

3) If the unit is operated too quickly, the front end of the tractor may have a tendency to jump up on encountering any rock or an area of heavily compacted soil.

**MAINTENANCE:**

**Daily** - Before each use check bolts, set screws and cotter pins to ensure they are tight and in good condition.

**Other** - Pre-season servicing includes a thorough cleaning, and inspection. All nuts and bolts should be tightened.

- Occasionally all nuts and bolts should be tightened to the torques suggested in the owner's manual.

- Post-season servicing. To prevent rust and corrosion during winter storage:

- Clean the unit thoroughly.

- Apply rust preventing substance to all exposed metallic surfaces.

**Special maintenance equipment required** - None.

**Major repair items** - The shank points require replacement approximately once a season.

**Ease of Repair** - Very good.

**Parts availability** - Very good. Models currently in use are made by large reputable manufacturers with good parts supplies.

**PRODUCTION RATES:**

A single shank subsoiler operating at 30 cm spacing can subsoil approximately 1.5 hectares in eight hours.

A dual shank unit can subsoil approximately 3 hectares in eight hours.

**USERS' ASSESSMENT**

**ADVANTAGES:**

1) The design of the subsoiler enables it to operate at a greater depth than regular plough type implements.

2) The subsoiler breaks up compaction layers deep in the soil while causing a minimum of mixing in the plough zone.

3) Provides a cost-effective means of improving drainage if tiles are not installed.

4) Unlike standard mouldboard ploughs relatively few adjustments are required.

**DISADVANTAGES:**

None were noted.

**OPERATIONAL GROUP:**

**2** Ground Preparation

**EQUIPMENT TYPE:**

**2.11** Seedbed Pulverizer

**MAKES AND MODELS IN USE:**

Forrest City, Do-all Model 0085

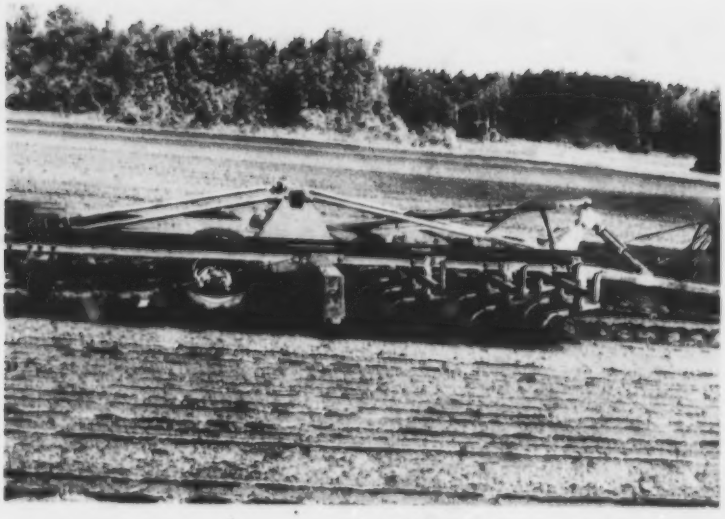
**MANUFACTURER AND DISTRIBUTOR**

Forrest City Machine Works Inc.,
P.O. Box 984,
Forrest City, Arkansas
U.S.A. 72335

Telephone: (501) 633-1514

Distributor: Robert H. Laning and Sons Ltd.,
Waterford, Ontario
N0E 1Y0

Telephone: (519) 443-8601



Seedbed pulverizer — Kemptville Nursery.

**CURRENT USERS AND NUMBER OF UNITS:**

| | |
|---|---|
| Chapleau | - |
| Dryden | - |
| Gogama | - |
| Kemptville | 1 |
| Midhurst | - |
| Orono | - |
| St. Williams | - |
| Swastika | 1 ** |
| Thessalon | - |
| Thunder Bay | - |

** Swastika is using a John Deere Model 740 cultivator modified by the addition of Pronorollers, and heavy duty rolling harrows, to perform the tasks of a seedbed pulverizer.

**TECHNICAL INFORMATION**

**SPECIFICATIONS:**

**Model 0085, Do-all, A 2 Bar Do-all Seedbed Pulverizer.**

| | |
|---|---|
| Working Width | - 4 m |
| Approximate Weight | - 1816 kg |
| Tongue | - length 187 cm<br>- clevis hitch or single prong hitch<br>- tongue jack at 2270 kg. standard |
| Chisel Plough Section | - 19 heavy duty teeth<br>- teeth resettable with 11 cm of trip |

| | |
|---|---|
| Reel Section | - 2 spiral reels<br>- 34 cm diameter<br>- 4.5 cm solid axles |
| Harrow Section | - 2 sections of Flex-Harrow<br>- 1.4 cm by 16.5 cm diamond shaped teeth<br>- teeth are high carbon steel for durability |

Note: The specifications will vary considerably with the options chosen. There are forty different models of the Do-all when the different combinations are taken into consideration.

Model variations include:

1) Working width, 3-9.5 m
2) Folding or Non-folding (some models)
3) Number of chisel plough teeth, 15 - 47
4) Number of spiral reels, 2 - 4
5) Number of harrows sections, 2 - 8
6) Frame construction, 2 or 3 bar
7) Optional rolling baskets

**OPTIONAL EQUIPMENT:**

1) Hitch-type: Clevis or single prong.
2) Rolling Baskets.

**SPECIAL MODIFICATIONS:**

1) Replaced the manual crank adjustment on the tongue of the unit with a hydraulic cylinder, allowing the unit to be levelled from the cab via hydraulic controls. The centre support rod from the new levelling cylinder required reinforcement due to the increased pressure exerted by the hydraulic cylinder. (Kemptville Nursery)

2) Swastika Nursery has modified the John Deere Model 740 cultivator to perform the function of a seedbed pulverizer by fitting it with new S-tines, 9.9 cm shovels and rolling baskets.

**PRIME MOVER**

**TYPE:**

Standard agricultural tractor.
(Four-wheel drive preferred)

**NET POWER REQUIREMENT:**

Model 0085 requires 63 - 75 kw.

**ATTACHMENT:**

Standard draw-bar with either a clevis or a single-prong hitch.

Tractor hydraulic system.

## TASK PERFORMED

Cultivates, mixes soil, and levels land to prepare new seedbeds.

## HOW IT WORKS

### WORKING PRINCIPLE:

A seedbed pulverizer is designed to perform the duties of several of the implements normally used in land preparation. In one operation the unit will plough, break up clods, and level out the soil.

The chisel teeth plough through the soil, breaking and loosening compaction. The spiral reels crush soil clods and churn the loosened soil. The harrows sections further break up soil clods and level out depressions or hummocks in the field.

### GENERAL DESCRIPTION:

At first glance the seedbed pulverizer resembles a standard chisel plough. A heavy steel frame connects to an agricultural tractor through a hinged draw-bar.

The front section of the frame is set up as a chisel plough to break up the soil. Steel bars bolted across the width of the frame provide mounts for the chisel teeth. The spring-loaded chisels can trip and reset when they encounter a heavily compacted region of soil or a stone.

The chisel teeth are equipped with replaceable duck-bill shares- wide, hardened steel tips that bolt to the ends of the chisel teeth. The wide-spreading design of these tips transfers considerable lifting and separating force to the soil above the share as it passes through the soil.

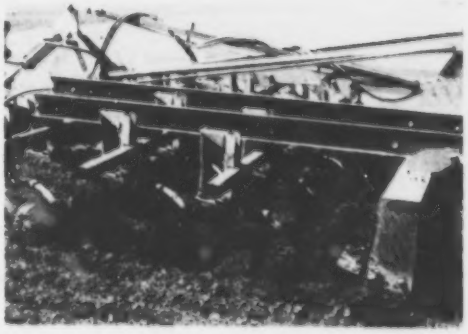
The spiral reels break down lumps and mix the soil. The reels are non-powered free-wheeling cylinders constructed of spiralled steel blades fixed about the central axle. The entire assembly is spring-loaded to protect the reels if they encounter large rocks or other objects.

As the unit is pulled along the field the reels rotate. The spiral blades dig into the soil surface, crushing and breaking up soil clods. At the same time soil is picked up by the blades and churned by the revolving motion.

Immediately following the reels are two or more sections of flex-harrows. The flex-harrow sections have many vertical teeth that extend into the upper few cm of the soil. As these teeth are dragged along the soil they spread the soil out horizontally, thereby knocking over any hummocks and filling in any depressions. The horizontal mixing action also serves to pulverize remaining large clods of soil.

The operating depth and level of the unit are controlled by two hydraulic cylinders. The main depth-control mechanism is through the cylinder, which controls height setting of two pneumatic gauge wheels located just behind the spiral reels. A second hydraulic cylinder on the tongue hinges the tongue to level out the unit.

Proper operating depth and level are important. If the unit is set with the front too high the weight of the unit will ride on the reels resulting in undue stress on the reel mechanism and cause the chisel teeth to plough at a shallow depth. If either the front of the unit or the depth wheels is set too low, the chisel teeth will plough too deep, requiring the tractor to work much harder.



Chisel tines and spiral reels in operation.

**LIMITING FACTORS:**

1) Stones tend to bend and break the blades on the reels.

## OPERATIONAL INFORMATION

**STAFF REQUIREMENTS:**

One person is required to drive the tractor and make appropriate adjustments for proper operation of the unit.

**SAFETY ASPECTS:**

Standard safety practices for farm machinery should be observed.

**MAINTENANCE:**

**Daily** - grease unit.

- inspect the reels, chisel teeth and harrow teeth for signs of wear, cracks or breakage.

Use of a Do-all Model 0085 at the Kemptville Nursery has shown that stones are a problem for the reel mechanism. On average the reels must be replaced once a season.

**PRODUCTION RATES:**

Travel Speed - 8 to 13 km/hr.

Production - Approximately 1 ha/hr.

## USERS' ASSESSMENT

**ADVANTAGES:**

1) Only one piece of equipment is required to prepare the seedbed. This single unit in one operation essentially replaces three different operations (discing, harrowing with spring-tooth harrows, and with drag harrows). This saves time, labour, fuel and equipment.

**DISADVANTAGES:**

1) Requires a tractor with a larger power rating than most other nursery equipment. Must have access to at least a 75 kw tractor, preferably with four-wheel drive.

2) If the soil in which the unit is to be used is prone to stoniness, repairs or seasonal replacement of the reels should be anticipated.

**OPERATIONAL GROUP:**

**2** Ground Preparation

**EQUIPMENT TYPE:**

**2.12** Field Vacuum

**MAKES AND MODELS IN USE:**

1) Brouwer, Model BV85

**MANUFACTURERS AND DISTRIBUTORS:**

1) Brouwer Turf Equipment Ltd.,
Woodbine Avenue,
Keswick, Ontario
L4P 3E9
Telephone: (416) 476-4311
Telex: 065-24161
Fax: (416) 476-5867

Distributors:

(i) Westmetro Ford Equipment Sales Ltd.,
95 Clairville Drive,
Rexdale, Ontario
M9W 6K9
Telephone: (416) 675-3660

(ii) Ottawa Tractor Sales Ltd.,
RR 2,
Carp, Ontario
K0A 1L0
Telephone: (613) 836-5912

**CURRENT PRICE:**

Brouwer - Vac BV85, Suggested List: $17,281.00

Note: Price is F.O.B. Keswick, Ontario.

**CURRENT USERS AND NUMBER OF UNITS:**

| | |
|---|---|
| Chapleau | - |
| Dryden | - |
| Gogama | - |
| Kemptville | - |
| Midhurst | - |
| Orono | - |
| St. Williams | 1 |
| Swastika | - |
| Thessalon | - |
| Thunder Bay | - |

Brouwer-Vac.

## TECHNICAL INFORMATION

### SPECIFICATIONS:

**Model BV85**

Overall Dimensions:

| | |
|---|---|
| Height | - 248.9 cm |
| Width | - 205.7 cm |
| Length | - 652.7 cm |
| Weight | - 1542 kg |

Load Box Dimensions:

| | |
|---|---|
| Length | - 396 cm |
| Width | - 188 cm bottom - 163 cm top |
| Height | - 40 cm |
| Volume | - 9.5 m3 |

General Information:

| | |
|---|---|
| Hitch Type | - 5 cm quick-release ball |
| | - Dimensions from draw bar hitch to tires 394 cm |
| Tires | - Tandem 11 L-15 Farm service ribbed flotation tires |
| Vacuum Pick-up | - Hydraulically adjustable full floating suction head |
| | - Quick-adjust gauge height wheels |
| | - Maximum width 203 cm |
| Discharge Mechanism | - a full-width chain conveyor and a hydraulically operated rear door |
| PTO Shaft | - Constant-velocity joint drive shaft with a slip clutch and over-running clutch |

### OPTIONAL EQUIPMENT:

1) Spring balanced Vac-Hose extension
   Suggested List - $1,649.00
2) Suction head extension to 305 cm.
   Suggested List - $564.00

### SPECIAL MODIFICATIONS:

1) Two adjustable plates each 38 cm long were mounted to the sides of the suction head opening to create a 127 cm pick-up width (corresponding to the width of the nursery-beds) across the center portion of the pick-up head.

2) Nine adjustable tines were mounted directly in front of the pick-up head to loosen the chips just prior to vacuuming.

3) A semi-flexible rubber skirt, 7 cm wide, was mounted below the pick-up head on adjustable plates to protect the seedling tops as the suction head passes overhead.

The pick-up head is mounted by a hinge arrangement to the back of the blower unit. The head height is hydraulically controlled by a cylinder mounted just behind the trailer axle. For transport the head is pulled up under the frame and locked to the frame with chains on either side of the unit.

The full head is 203 cm wide. For nursery use this width is reduced to the standard nursery-bed width by attaching adjustable plates over the suction head opening on both sides of the head.

Two adjustable gauge wheels on the back of the head maintain the head at a pre-set height to ensure that it does not drop low enough to damage the seedlings. A semi-flexible rubber skirt attached to the underside of the head further protects the seedlings by allowing the operator to maintain a greater distance between the seedlings and the head.

On the front of the head nine adjustable tines fit between the rows of seedlings to loosen the wood-chips just prior to vacuuming. The chips tend to become slightly compacted after the snow and moisture of the winter and early spring. The tines are carefully adjusted to ensure that they align with the spaces between rows and have sufficient downward pressure.

The unit can also be used to pick up stray piles of chips or debris that cannot be conveniently gathered by the regular mobile operation of the unit. For this type of operation an optional manual nozzle is used. The nozzle and flexible hose are mounted to ports on either side of the blower housing. For this type of operation, an extra person walks beside the trailer and manipulates the hose and nozzle. To facilitate ease of handling of the hose, it is suspended from an adjustable support arm mounted to the side of the load bin and is fitted with an end nozzle with handles.

During operation of the manual nozzle the flow of air into the regular pick-up head is shut off with a steel plate. A second steel plate at the hose mount on the side of the blower is opened to allow the suction to operate through the hose attachment.

All of the hydraulic functions of the unit (i.e. rear doors, unloading and head height adjustment) are controlled by the tractor operator through a single hydraulic control junction box mounted on the tractor.

**LIMITING FACTORS:**

1) Wet wood-chips hinder the ability of the Brouwer-Vac to pick up the material, as the chips tend to stick together as a mat on the bed surface. If the chips are wet or there is a wet layer underneath, two passes with the machine may be required, with enough time between passes to allow the remaining chips to dry.

2) When operating the unit on dry fine soils it may be necessary to arrange the passes so that the unit is always down-wind of the operator, because of the large amount of dust picked up and blown around by the unit. Preferably the unit should be operated on a day with a brisk wind which will eliminate the dust cloud.

## OPERATIONAL INFORMATION

### STAFF REQUIREMENTS:

**Operator** - One person is required to drive the tractor and operate the hydraulics for the field vacuum.

**Support** - One observer is required to monitor the height of the pick-up head as it passes over the seedlings.

### SAFETY ASPECTS:

1) Both the operator and observer should wear cover- alls, goggles and a respirator to protect them from the heavy dust conditions created by the unit, particularly with dry, light soil.

2) The operator and observer should ensure that all tools, equipment or other stray objects are kept clear of the pick-up head to prevent loss or damage to the items or possible damage to the blower.

3) When plugging or unplugging the quick disconnect hydraulic couplings, ensure that the controls are in the off position.

4) Ensure that all personnel are clear before opening or closing the rear door on the load bin.

### MAINTENANCE:

**Daily** - General servicing including greasing, cleaning and general inspection.

**Seasonal** - Pre-season: inspection and servicing.

- Post-season: clean-up, inspection, worn parts replacement and servicing in preparation for storage.

### PRODUCTION RATES:

For proper operation the Brouwer-Vac travels at a speed of approximately 4 km per hour.

At Dryden Nursery it has been found that the field vacuum can clean two 500-meter beds in 10 to 15 minutes, achieving approximately 75% of maximum load capacity. Unloading at a nearby chip storage area required 30 minutes on average, including transport time.

## USERS' ASSESSMENT

### ADVANTAGES:

1) Only two people are required to operate the unit. To do the same work in the same time would require 20 people removing chips manually.

2) There is less seedling damage during the vacuum chip removal operation than in a similar manual operation.

### DISADVANTAGES:

1) Dust - The suction into the pick-up head tends to pick up the light exposed nursery soils. The soil particles are carried out through the mesh at the top of the load bin along with the rush of air from the blower, creating a large dust cloud.

## PRIME MOVER

### TYPE:

Standard agricultural tractor.

### NET POWER REQUIREMENT:

26 - 34 kw.

### ATTACHMENT:

Standard draw-bar hitch fitted with a 5 cm ball.

Quick coupler connections to one set of dual hydraulic take-offs on the tractor hydraulic system.

## TASK PERFORMED

The Brouwer-Vac is used exclusively for removing wood-chips from 1+0 spruce beds and some grafted stock beds at the Dryden Tree Nursery.

## HOW IT WORKS

### WORKING PRINCIPLE:

The Brouwer-Vac operates on the same principle as a standard household vacuum cleaner. A blower mechanism creates a vacuum in the pick-up head. In this case the pick-up head is set up so that it travels along the nursery-bed very close to the tops of the seedlings. The air rushing into the head picks up sawdust and wood-chips from around the seedlings and blows the material through a chute into a refuse bin.

### GENERAL DESCRIPTION:

The Brouwer-Vac was designed for clean-up of debris such as leaves, grass clippings, trash, and general litter from large areas such as golf courses, parks, sod farms, road right-of-ways and parking lots. Its design is therefore suitable for removal of mulching materials used to protect young stock over the winter.

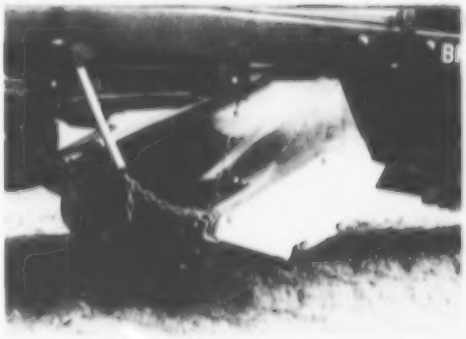
The unit is essentially a large vacuum mounted in a single-axle tandem wheeled trailer. Much of the trailer frame is occupied by the large 9.5m$^3$ steel-walled load bin.

The vacuum mechanism is mounted on the tongue directly in front of the bin. The pick-up head is suspended from the trailer frame directly behind the blower. An optional manually operated vacuum hose may be connected to the side of the vacuum mechanism.

The load bin is fabricated with corrugated steel walls and an open mesh roof. When the unit is operating, the mesh roof allows the rushing air from the blower to escape while trapping all debris within the bin.

The floor of the bin has a full-width hydraulic conveyor that works together with a set of hydraulically operated rear doors to provide automatic unloading.

The vacuum mechanism is driven through a belt drive and shaft connection to the PTO of the tractor. In normal operation the PTO is set to a maximum of 500 rpm. A large blower creates the suction required for the vacuum action at the pick-up head. Materials picked up by the vacuum are blown through a curved chute into the load bin.



Brouwer-Vac pick-up head in raised transport position.

2) Rain - The field vacuum cannot vacuum the chips properly if they are too wet. Unlike manual crews, the unit cannot operate during rainy weather.

**OPERATIONAL GROUP:**

**2** Ground Preparation

**EQUIPMENT TYPE:**

**2.13** Tedders and Rakes

**MAKES AND MODELS IN USE:**

1) Kuhn, GF 452 M Tedder; GA 300 GT Gyro-rake; GRS 25 Gyrorake

2) Deutz-Allis (originally Deutz-Fahr) Tedders, KH 500DN
Rakes, KS 85, KS 150

3) Deutch - Gehring, Model N/A

4) Fella-Werke, Model TS 325 D

**MANUFACTURERS AND DISTRIBUTORS:**

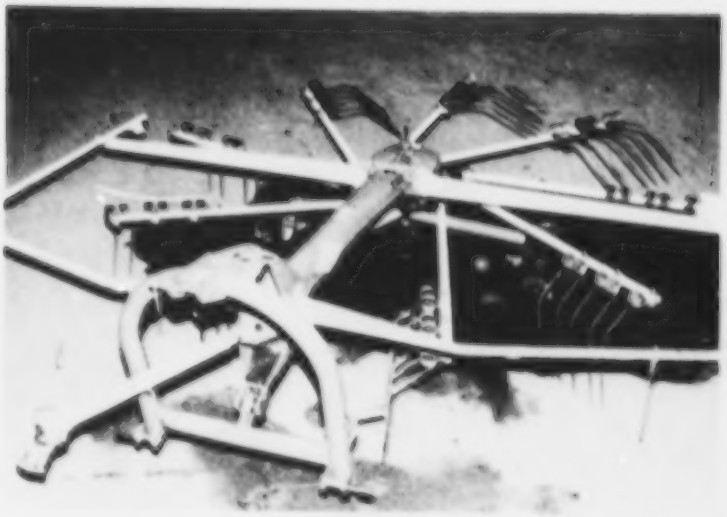
1) Deutz-Allis Corporation Canada Ltd.,
6290 Kestrel Road,
Mississauga, Ontario
L5T 1T3
Telephone: (416) 674-5336
Distributors: Dealerships throughout Ontario.

2) Fella-Werke GMBH,
8501 Feucht/Nuremberg,
West Germany
Telephone: (09128) / 73-1
Telex: 626131 / 622397

Distributors:

i) Halnor Farm Equipment,
RR 5,
Waterford, Ontario
N0E 1Y0
Telephone: (519) 443-7467

ii) Doughty & Williams Ltd.,
RR 1,
Jarvis, Ontario
N0A 1J0
Telephone: (519) 287-2273
(519) 664-3625



Rotary rake at Midhurst Nursery.

**CURRENT USERS AND NUMBER OF UNITS:**

| | Tedders | Gyrorake |
|---|---|---|
| Chapleau | - | - |
| Dryden | - | 1 (iv) |
| Gogama | - | - |
| Kemptville | 1 | 1 (i) |
| Midhurst | - | - |
| Orono | 1 (ii) | - |
| St. Williams | - | 1 (iii) |
| Swastika | 1 (iv) | 1 (iv) |
| Thessalon | - | - |
| Thunder Bay | - | 2 (i) |

Note: i) Deutz-Fahr, Deutz-Allis ii) Deutch-Gehring iii) Fella-Werke iv) Kuhn

**TECHNICAL INFORMATION**

**SPECIFICATIONS:**

1) **Model KH500 Tedders**

| | |
|---|---|
| Working width | - 5.23 m Transport width |
| No. Rotors | - 4 Counter-rotating rotors |
| No. Arms | - 6 Arms per rotor |
| PTO Requirements | - 540 RPM drive |
| Tires | - 16 x 6.50 x 8 Flotation tires |
| Approx. Weight | - 220/236 kg |

Note: Weights are for trailing hitch and three-point hitch versions respectively.

2) **Model Deutz-Allis KS1.50AS / KS1.50DN rotary rakes, trailing hitch and three-point hitch versions respectively**

| | |
|---|---|
| Working Width | - 3.3 m |
| Transport Width | - 2.5 m |
| No. Rotors | - 1 |
| No. Arms | - 8 |
| Height | - Variable adjustment |
| PTO requirements | - 540 RPM |
| Wheels | - Replaceable ball bearing hubs |
| Tires | - 16 x 6.50 x 8 flotation tires |
| Approx. Weight | - 316 / 352 kg |

## TASK PERFORMED

Tedders are used to uproot cull trees still buried in the soil. The action of the tedders spreads cull and debris on the soil surface for later pick-up and disposal.

Rakes are used to windrow cull trees in preparation for removal. Rakes can also lift patches of cull still rooted in the soil if the soil is not packed and if the tines are set so that they dig into the soil surface slightly.

## HOW IT WORKS

### WORKING PRINCIPLE:

Rotary rakes and tedders operate on a principle similar to that of the common leaf-rake. Both implements utilize a series of long flexible tines that rapidly brush over or slightly below the soil surface. The rapid whisking motion of the tines picks up debris and tosses in the direction of travel of the tines.

Tedders are designed to turn over and re-spread cut hay for drying in farm fields. For nursery use tedders are adjusted so that the tines work into the upper 5 - 8 cm of soil. The rotating tines uproot cull trees and debris remaining in the soil after lifting operations.

Rotary rakes are designed for windrowing hay in farm fields. At tree nurseries, rakes windrow loosened or lifted cull trees.

### GENERAL DESCRIPTION:

Rotary Rakes:

Rotary rakes consist of a single central rotating hub with a series of arms extending radially. Each arm has two to three pairs of long spring-loaded steel tines extending downwards to the ground.

Each arm is designed to swivel at preset times in its revolution about the hub. As the arms swivel, the tines are raised or lowered with respect to the ground surface.

A shaft joins the PTO to the gears inside of the hub, thereby providing the power necessary to rotate the hub and arm arrangement. For lubrication, the hub casing is normally filled with oil or packed with grease.

During operation the hub rotates counter-clockwise in a plane parallel to the surface of the ground. Each arm follows a series of motions to produce the characteristic raking action.

At the beginning of each rotation, the tines are raised and almost parallel with the soil surface. In the first quarter revolution, along the right side of the unit, the tines come into contact with the soil surface. They gather cull and debris throughout the second and part of the third quarter revolution before the arms swivel back in the opposite direction, lifting the tines from the soil surface. The collected debris is released and tossed to the left side of the unit. The tines are now in the raised position until they reach the right side of the unit and begin the cycle again. The combined gathering action of the arms produces a windrow of the debris materials along the left side of the unit.

To maintain the hub and raker arms at the proper operating height, an adjustable yoke-type frame with pneumatic flotation tires is mounted beneath the central hub. On some makes the yoke frame swivels freely to allow for easier turning. This swivelling feature is particularly important on three-point hitch versions with non-flexing attachments.

Close-up of rotary rake tines.

Operating height is adjusted by setting the height of the three-point hitch or adjusting a manual crank on the yoke frame of trailing hitch versions.

Some makes further enhance the maneuverability of the three- point hitch versions by utilizing a swivelling three-point hitch arrangement. The swivelling three-point hitch allows the unit to swivel like a trailing hitch while the unit is operating on the ground. When the hitch is raised the unit automatically centres and locks to prevent swaying during transport.

Tedders:

Tedders are similar to rotary rakes in that the functional part of the implement is a series of flexible tines on arms rotating about a central hub. However, there are usually two or more rotating hub mounted side by side on the frame parallel with the back of the tractor. The arms on the tedder hubs are generally shorter than those on the rake and do not swivel. The single pair of tines is mounted on each arm so that they angle out diagonally from the ends of the arms.

During operation the tractor PTO powers the main drive gear in the centre of the frame. Two transverse mounted shafts transfer the rotation out to the various hubs across the frame.

The plane of rotation for the arms is angled with respect to the surface so that the tines only touch the ground along the front portion of their rotation.

The diameter of the raking arcs made by the rotation of adjacent hub and arm arrangements overlap. The arms and tines of adjacent hubs are geared and inter-meshed so that they do not bind or come in contact with each other. The overlap in the rotation of adjacent hubs ensures that the coverage of the tedders will be a continuous swath the full width of the unit.

For nursery use the tines are set up so that they dig into the soil a maximum of 8 cm along the front portion of their rotation. The operating height and the tine penetration depth is determined by an angled depth-setting wheel mounted beneath each of the rotating hubs. The wheels also raise the unit for transport by swivelling and locking them 180 degrees into the transport position. The design of the mount causes the frame to be lifted as the wheel is rotated towards the transport position.

Fine adjustment of the depth of tine penetration is accomplished by altering the tilt of the frame. On three-point hitch versions, this is done by adjusting the toplink on the hitch. On the trailing versions, a manual crank at the junction of the tongue and the transverse frame is used to set the angle of operation.

On tedders with four or six rotating hubs, the frame is usually hinged to permit the side extensions to be folded in to narrow the unit for transport.

Some of the wide, multiple-hub versions incorporate an articulating frame which allows each hub to respond to a depression in the field, thereby maintaining an optimum operating height independent of the other hubs.

Individual rotating hub on a set of tedders.

**LIMITING FACTORS:**

1) Soil moisture - Conditions must be very dry for these implements to function properly. Conditions that are too wet make it more difficult for the tines to pull the cull trees free of the soil. Wet soil will also build up on the tines and mechanism.

3) **Model Kuhn GA 300 GT Rotary Rake**

| | |
|---|---|
| Working Width | - 3.2 m |
| Transport Width | - 2.7 m |
| No. Rotors | - 1 |
| No. Arms | - 9 |
| No. Tines Per Arm | - 3 pairs |
| Height | - Adjustable |
| PTO Requirements | - 540 RPM, 20 HP |
| Wheels | - Fixed, no swivel |
| Tires | - 15.6 x 6 flotation type |
| Approx. Weight | - 283 kg |

4) **Model Faila-Werke TS 325 D**

| | |
|---|---|
| Working Width | - 3.15 m |
| Transport Width | - 2.90 m |
| No. Rotors | - 1 |
| No. Arms | - 10 |
| Tires | - 16 x 6.5 flotation tires |
| Approx. Weight | - 145.1 kg |

**OPTIONAL EQUIPMENT:**

1) Most manufacturers offer the option of either the trailing draw bar or a three-point hitch attachment for both the tedders and the rakes.

**COMPLEMENTARY EQUIPMENT:**

Tedders and rakes are used in conjunction with implements that will vacuum, bale or fork the cull trees and debris from the windrows left in the nursery field.

**PRIME MOVER**

**TYPE:**

Agricultural tractor with a mechanical PTO connection.

**NET POWER REQUIREMENT:**

Minimum 22 kw.

To operate the rotor mechanism requires 11 kw of the minimum power requirement shown.

**ATTACHMENT:**

Three-point hitch and trailer draw-bar hitch attachments are used.

Both tedders and rakes require a connection to the mechanical PTO of the prime mover.

2) Soil compaction - Neither unit will properly and efficiently lift cull seedlings from seedbeds in which the soil has not been previously loosened. Normally a single undercutting with the lifting blade will sufficiently loosen the soil.

3) Amount of cull - When there is a high cull level, such as when full beds are culled or when the cull has been trampled, the field may require an initial raking, followed by cultivation and a second raking.

## OPERATIONAL INFORMATION

### STAFF REQUIREMENTS:

One person is required to operate the tractor and make appropriate adjustments to the tedders or rake.

### SAFETY ASPECTS:

1) Always disengage the PTO drive before dismounting the tractor.

2) All guards should be properly installed and in place at all times while the implement is in operation.

3) All personnel should remain well clear of the implement while it is in operation.

4) Care must be exercised when raising units equipped with swivelling three-point hitch. Note that such hitches will automatically swing back into the central position when they are raised. Personnel must remain clear of the area between the tractor and the implement to avoid being struck by the implement as it centres.

5) Use of a dust mask or a cab-type tractor with filtered air flow is recommended to protect the operator from the dust produced when operating in very dry conditions.

### MAINTENANCE:

**Daily** - Grease PTO fittings.
- Grease rake fittings at the swivel points of each arm.

**Seasonal** - Change oil in hub or repack with grease if model has grease-filled hub(s).

Check oil levels in the hubs regularly to minimize the chance of oil seal leakage and subsequent hub damage.

Comments: Tines may be prone to premature wear and breakage if they are operated at a depth greater than 8 cm.

## USERS' ASSESSMENT

### ADVANTAGES:

1) Cull clean-up can be operated as a one-man operation when tedders, rakes and some form of pick-up are combined.

2) Tedders and rakes operate much faster than spike-tooth or chain-harrow drags used for cull clean-up.

### DISADVANTAGES:

1) Because these units were designed for raking and fluffing cut hay in farm fields, the tines can not be set to scour much deeper than 8 cm.

**OPERATIONAL GROUP:**

**2** Ground Preparation

**EQUIPMENT TYPE:**

**2.14** Field Packers

**MAKES AND MODELS IN USE:**

1) Farmhand Inc., Series 40 Cultipacker

**MANUFACTURERS AND DISTRIBUTORS:**

1) Farmhand Inc.,
6421 Hazeltine Blvd.,
Excelsior, Minnesota
55331 U.S.A.
Telephone: (612) 474-1941
Telex: 290764
Distributor: DFK Equipment Sales Inc.,
RR 4,
Elmira, Ontario
N3B 2Z3
Telephone: (519) 664-2651
(519) 664-3625

**CURRENT USERS AND NUMBER OF UNITS:**

| | | |
|---|---|---|
| Chapleau | - | |
| Dryden | 1 | MNR |
| Gogama | 1 | MNR |
| Kemptville | - | |
| Midhurst | 1 | MNR |
| Orono | 1 | Farmhand, Series 40 |
| St. Williams | - | |
| Swastika | - | |
| Thessalon | - | |
| Thunder Bay | - | |

**PRICE OF CURRENT MODELS:**

Series 40 Cultipacker, Width 3.67 meters
$2,051.00 w/ 43.2 cm Crowfoot Rollers

Farmhand cultipacker — Orono Nursery.

## TECHNICAL INFORMATION

### SPECIFICATIONS:

**Series 40 Straight Cultipacker**

| | |
|---|---|
| Rollers | - Smooth 43.2 cm or 48.3 cm diameter<br>- Crowfoot 43.3 cm or 50.8 cm diameter |
| Rolling Width | - 1.25 m to 4.98 m |
| Transport Width | - 1.47 m to 5.16 m |
| Number of Wheels | - 12 to 46 smooth rollers |
| | - 8 to 31 crowfoot rollers |
| Approx. Weight | - 265.4 to 1016.1 kg smooth rollers |
| | - 231.4 to 841 kg crowfoot rollers |

Note: Larger Farmhand Series 42 folding cultipackers are available with operating widths up to 11m. All have folded widths of 4.1m.

Note: The above dimensions refer to the commercially available Farmhand field packers. For details regarding homemade versions contact the staff of the nurseries listed.

### OPTIONAL EQUIPMENT:

| | |
|---|---|
| 1) Reversible point scrapers | $297.00 for 3.66 m packers. |
| 2) Hydraulic transport wheels | $744.00 less 20 cm hydraulic cylinder and hose. |
| 3) Tongue jack | |

### SPECIAL MODIFICATIONS:

Two, three-tine spring-tooth cultivator sections were attached to either side of the packer frame, directly behind the tractor wheels. The tines loosen soil compacted by the passage of the tractor wheels over the nursery bed. (Orono Nursery)

## PRIME MOVER

### TYPE:

Standard agricultural tractor. The tractor must have hydraulic capabilities if the hydraulic transport wheel option is to be utilized.

### NET POWER REQUIREMENT:

Minimum of 14.9 kw.

### ATTACHMENT:

Draw-bar Hitch.

## TASK PERFORMED

Bed packers are used to pack the soil prior to transplanting. Packing produces a finer seedbed soil structure, reduces air pockets and minimizes moisture loss due to evaporation.

## HOW IT WORKS

### WORKING PRINCIPLE AND GENERAL DESCRIPTION:

Most homemade field packers are fabricated from a 3 to 3.5 m section of large diameter piping. The ends are welded shut with an axle running through the centre. A plug is inserted into one end of the closed tube so that water may be added for extra packing weight. The packing drum is mounted by bearings suspended from either end of a draw tube, which connects by a draw-bar to the tractor.

The smooth-roller type of field packer simply uses weight and its smooth surface to press down on the cultivated soil, crushing any soil clods and pressing the soil particles close together.

Commercially available field packers generally consist of a series of individual, closely spaced packing wheels on a high-strength steel axle supported by two or three bearings suspended from a gang tube that stretches across the width of the unit. The assembly is connected by a draw-bar to the tractor.

The packer wheels are available in either smooth or crowfoot roller styles. Smooth rollers have a wide flat-surfaced rim with a raised serrated ridge extending from the centre of the rim around the entire circumference. The flat roller surface packs the soil surface while the ridge probes into the soil surface to further break up soil clods.

Crowfoot rollers are narrow spoked wheels with many short, staggered, horizontal packing extensions protruding from the sides of the narrow wheel rim. The crowfoot roller design results in a more aggressive clod-breaking action and a loosely mulched bed surface. The individual packing extensions press more deeply into the soil surface than does a simple packing drum or a smooth packing wheel. The soil is packed by the packing extensions while the area between adjacent packers and adjacent wheels remains loose and is fluffed up. The result is a bed surface that is packed with an unevenness formed by the many tiny angle depressions and peaks termed an edge. The soil edge minimizes wind erosion in fine soils.

To facilitate transport of field packers between compartments and along nursery roadways, wheels may be attached to the packer frame to lift the packers clear of the ground. Farmhand packers such as the Series 40 in use at Orono Nursery can be equipped with 7.6 x 20 cm hydraulic cylinder, which allows two pneumatic transport wheels to be raised and lowered automatically by the operator.

It is important to pack evenly over the entire compartment. Small patches or linear regions within a compartment with greater compaction levels may upset the operation of one or more of the transplanter units resulting in undesirable transplanting quality. The staff at Orono Nursery mounted two sections of spring-toothed harrows to the packer frame in front of the packing gang, directly behind the main tractor wheels. The operating depth of the tines is controlled by manual cranks on the frame. The harrow tines loosen compaction caused by the tractor wheels.

### LIMITING FACTORS:

1) Soil must be loosened by one of the tillage implements prior to packing for the unit to function properly.

2) Soil moisture is very important. If the soil is too wet it will stick to the packer, clog the crowfoot rollers, and generally impede achievement of the desired bed packing structure.

Crowfoot packer wheel gang.

## OPERATIONAL INFORMATION

### STAFF REQUIREMENTS:

One person is required to drive the tractor, adjust the harrows depth, and to raise and lower the transport wheels at the end of each compartment.

### SAFETY ASPECTS:

Standard safety practices for use of agricultural equipment.

Ensure that all personnel are clear of the unit prior to raising or lowering the transport wheels and before commencing operation.

### MAINTENANCE:

The simple design and function of field packers necessitates only standard maintenance procedures.

- Grease all bearings regularly.
- Inspect and replace packer wheels as required.
- Inspect and repair the hydraulics regularly.

**Special maintenance equipment required** - None.

**Major repair items** - None identified.

**Ease of repair** - Repair procedures are generally straight forward. Commercial models incorporating the packer wheel design will require somewhat more involved repair procedures if replacement of one or more of the centrally located wheels is required.

**Parts availability** - Good.

### PRODUCTION RATES:

2.4 ha/hr.

## USERS' ASSESSMENT

### ADVANTAGES:

1) The main advantage of the crowfoot packer over the straight roller packer is that it produces an edge on the soil that reduces wind erosion.

2) Any packer reduces loss of soil moisture, as large clods are broken up, air pockets are reduced or eliminated, and the soil particles are compressed closer together.

### DISADVANTAGES:

None noted.

**OPERATIONAL GROUP:**

**2** Ground Preparation

**EQUIPMENT TYPE:**

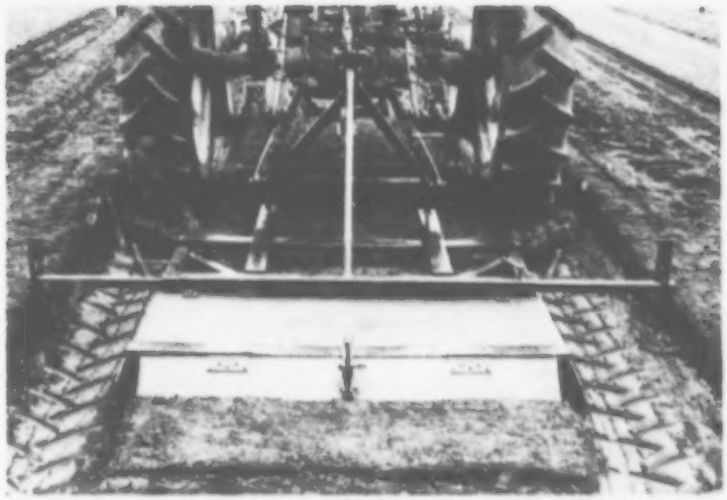
**2.15** Bed-former

**MANUFACTURERS AND DISTRIBUTORS:**

All of the units currently in use have been fabricated by Ministry staff.

**CURRENT USERS AND NUMBER OF UNITS:**

| | |
|---|---|
| Chapleau | 1 |
| Dryden | 1 |
| Gogama | 1 |
| Kemptville | — |
| Midhurst | 1 |
| Orono | 1 |
| St. Williams | — |
| Swastika | 1 |
| Thessalon | 1 |
| Thunder Bay | — |



Bed-former in operation at Midhurst Nursery.

**TECHNICAL INFORMATION**

**SPECIFICATIONS:**

The following dimensions are typical of the bed-formers in use at many Ontario provincial tree nurseries. Note the actual specifications vary depending on nursery requirements.

| | |
|---|---|
| Overall length | -208.3 cm |
| Overall Width | -180.3 cm |
| Width of Formed Bed | -149.9 cm |
| Materials | - .6 cm plate steel (Dryden Tree Nursery) |

**COMPLEMENTARY EQUIPMENT:**

1) Rollers or roller/groovers.
2) Broadcast or band seeders.
3) Seedcovering unit.
4) Hydromulchers.

## PRIME MOVER

**TYPE:**

Standard agricultural tractor.

**NET POWER REQUIREMENT:**

Minimum of 22 kw.

**ATTACHMENT:**

Three-point hitch.

## TASK PERFORMED

Creates raised nursery-beds in preparation for spring and fall seeding.

## HOW IT WORKS

**WORKING PRINCIPLE:**

The bed-former has internal baffles that scoop the soil into a windrow. A wide horizontal plate flattens the top of the windrow. The hinged rear tailgate spreads and levels the windrow to the desired bed form.

Repeated adjacent passes of the unit along a nursery field will produce parallel raised nursery-beds with standard dimensions and intermediate pathways between the beds.

**GENERAL DESCRIPTION:**

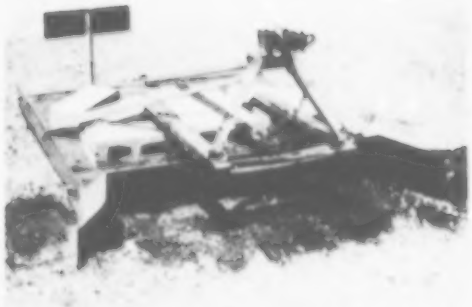
The bed-former mounts to the three -point hitch of any standard agricultural tractor. A welded frame of steel bar stock is used to construct a three-point hitch mount. A large horizontal steel plate forms the main deck of the bed-former. Vertical side-members welded to either side of the deck form a channel under the plate of the desired bed-shape. At the front end of the channel, two diagonal, plate-steel wings form a scoop-like arrangement. At the rear end of the channel, heavy steel hinges are used to attach a plate-steel tail-gate that drags along on the bed surface.

The unit is pulled behind a tractor driven in a straight line down the nursery field. The wings dig into the soil surface and scoop the soil into a windrow under the horizontal deck.

The unit is pressed onto the bed surface by concrete block or steel bar weights. The downward pressure forces the soil to fill out the channel while the vertical sides on the channel keep it within the desired bed dimensions.

As the newly formed bed passes from the rear opening of the former a hinged steel plate drags along the surface of the bed levelling out the surface.

Some nurseries have fixed the angle of the rear tailgate using an adjustable arm. The fixed version gives the operator the option of adjusting the levelling to a more uniform, consistent bed surface.



Unmounted bed-former with concrete blocks for additional weight — Dryden Nursery.

**LIMITING FACTORS:**

1) Depending upon the operator's skill, the device may be rather slow because of the effort required to maintain straight rows.

2) If the soil is too dry, it will not form well. The beds tend to crumble and blow easily. If the soil is too wet it tends to clump under the unit causing the beds to become gouged and have undesirable form.

## OPERATIONAL INFORMATION

**STAFF REQUIREMENTS:**

One person is required to drive the tractor. The operator should be a skilled driver in order to consistently and efficiently produce straight beds.

**SAFETY ASPECTS:**

Standard safety practices for the use of agricultural type machinery should be observed.

The operator should use proper lifting techniques when moving any weights associated with the unit.

**MAINTENANCE:**

The unit has very few moving parts and thus requires little if any maintenance other than a coat of rust-preventing paint annually. The hinged rear tailgate should be lubricated annually.

## USERS' ASSESSMENT

**ADVANTAGES:**

1) The implement produces a level, raised nursery bed that promotes drainage and warms the seedbed, which in turn promotes better germination and root growth in young tree seedlings.

**DISADVANTAGES:**

None noted.

**OPERATIONAL GROUP:**

**3** Sowing

**EQUIPMENT TYPE:**

**3.01** Broadcast Seeders

**MAKES AND MODELS IN USE:**

1) Gandy Company, Models 604 and 1010T

**MANUFACTURERS AND DISTRIBUTORS:**

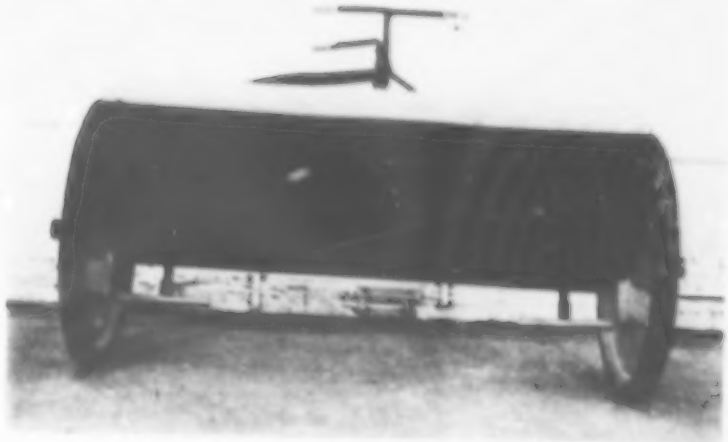
1) Gandy Company,
528 Gandrud Road,
Owatonna, Minnesota
55060 U.S.A.

Telephone: (507) 451-5430

Telex: 263227 GNDY UR

Distributor: Eastern Farm Machinery Ltd.,
340 Edinburgh Road North,
Guelph, Ontario
N1H 1E1

Telephone: (519) 836-2400



Hand operated 4 ft. Gandy seeder.

**CURRENT USERS AND NUMBER OF UNITS:**

| | | |
|---|---|---|
| Chapleau | 2 | 1, Model 1010 |
| Dryden | 1 | |
| Gogama | 2 | 1, Model 1010 |
| Kemptville | 1 | |
| Midhurst | 1 | |
| Orono | 1 | 1, Model 1010 |
| St. Williams | 1 | 1, Model 1010 |
| Swastika | 1 | 1, Model 1010 |
| Thessalon | 1 | |
| Thunder Bay | 1 | |

Unless otherwise noted, all of the above are Model 604 Gandy spreaders.

**PRICE OF CURRENT MODELS:**

Gandy 10T Series: 1010T $3,193.00; 1012T $3,379.00

Gandy 600 Series: 603 $1,124.00; 604 $1,170.00; 605 $1,217.00

Gandy 604 Nursery Special $1,240.00

## TECHNICAL INFORMATION

**SPECIFICATIONS:**

**1) Gandy 10T Series**

| | 1006T | 1008T | 1010T | 1012T |
|---|---|---|---|---|
| Size | 1.8 m | 2.4 m | 3.0 m | 3.7 m |
| Hopper Capacities | 0.25 m3 | 0.34 m3 | 0.42 m3 | 0.51 m3 |
| Hopper Construction | - 16-gauge steel, heavy-duty construction | | | |
| Rotor | - Hand-removable rotor assembly<br>- Specially designed for high flow rates with powdered materials | | | |
| Rotor Bearings | - Oil impregnated double-sleeve type with grease well and grease fitting | | | |
| Rate Gauge | - Direct acting micrometer cam-type precision gauge | | | |
| Hopper Bottom and Rate Control Slide | - Stainless steel<br>- Die-cut as a mated pair to ensure that the openings are uniform at all gauge settings | | | |
| Hopper Openings | - Diamond-shaped<br>- 3.8 cm long<br>- 9 cm separation | | | |
| Shut-off | - Hand operated on trailing models<br>- Hydraulic controls on mounted models, optional on trailing model | | | |
| Wheels | - 38 cm rims standard | | | |
| Wheel Bearings | - Cast iron<br>- Oil impregnated bearing with grease well | | | |
| Rotor Drive Mechanism | - Direct connection to wheel hub through a stub axle and clutch arrangement | | | |
| Weight | - 221 to 324 kg depending upon model | | | |

**2) Gandy 600 Series**

| | 603 | 604 | 605 | 604 N.S. |
|---|---|---|---|---|
| Size | 0.9 m | 1.2 m | 1.5 m | 1.2 m |
| Hopper Capacity | 0.05 m<br>54 kg | 0.07 m<br>73 kg | 0.08 m<br>90 kg | 0.07 m<br>73 kg |
| Note: Weights based upon contents with a density of 1041 kg/m. | | | | |
| Hopper | - Heavy duty construction<br>- 16-gauge stainless steel | | | |
| Rotor | - Four length-wise rods uniformly mounted around a core form the rotor assembly, which provides agitation to promote the free flow of materials from the hopper | | | |
| Rate Gauge | -Direct-acting precision cam-type gauge | | | |
| Hopper Openings | 5.5 cm | 6.0 cm | 5.7 cm | 6.0 cm |
| Shut-off | - Hand operated shut-off on push models<br>- Rope-controlled shut-off on units equipped with a tractor hitch | | | |
| Handle | - Standard equipment | | | |
| Tractor Hitch | - Optional equipment | | | |
| Wheels | - 50 cm x 4.4 cm wide semi-pneumatic tires or 66 cm x 5.1 cm wide tires | | | |
| Weight | 56 kg | 66 kg | 77 kg | 72 kg |

**NET POWER REQUIREMENT:**

Minimum of 22 kw for tractor-drawn spreaders.

**ATTACHMENT:**

A 600 Series spreader that is set up for connection to a tractor is normally attached via a clevis hitch to the draw bar of the tractor.

In cases where models of the 600 Series have been mounted within a frame along with packers, groovers or levellers, a custom- designed mounting arrangement is normally used. The frame is attached via the three-point hitch.

Spreaders from the 10T Series can be mounted in several different ways:

i) Clevis-type attachment to the tractor draw-bar.

ii) Three-point hitch.

iii) Front-mounted via a specially designed bracket attached to the front of the tractor frame.

## TASK PERFORMED

Units are used for broadcast seeding of nursery-bed. The larger models are also used to apply top dressings and fertilizers to fields prior to seeding or transplanting.

## HOW IT WORKS

**WORKING PRINCIPLE:**

Rotor bars in the hopper rotate in conjunction with the forward motion of the spreader. The movement of the rotor bars agitates the materials in the hopper maintaining an even flow of material down through a series of ports evenly spaced across the bottom of the hopper.

The speed at which the granules disperse through the openings is governed by the setting of the cam gauge that determines the size of the port apertures. The flow through the ports is started and stopped by a slider control accessible to the operator.

**GENERAL DESCRIPTION:**

The dominant feature of a broadcast spreader is the steel hopper assembly that forms the main body of the unit. The hopper is rectangular and tapers to the base. The width of the hopper determines the spreading width of the unit.

A mechanism for maintaining the flow of materials through the spreader is located behind a detachable plate at the base of the hopper. The mechanism consists of a rotor bar assembly mounted into the base of the hopper by bearings at each end of the hopper and one centrally located bearing. The assembly connects directly to the wheel hubs at the side of the hopper.

As the unit progresses along the seedbed, the turning of the wheels rotates the rotor assembly, thereby agitating the material in the hopper.

A slider plate connected to the operator's control is fitted over the stationary base plate of the hopper. A series of diamond- shaped holes in both plates have exactly the same size and spacing. Shifting the slider plate opens and closes the aperture and controls the rate of flow.

The controls for operating the slider plate consist of a lever arrangement at the base of the hopper. On hand-operated models, with a rear-mounted tubular handle, a rod and lever extend back along the handle

for ease of access by the operator.

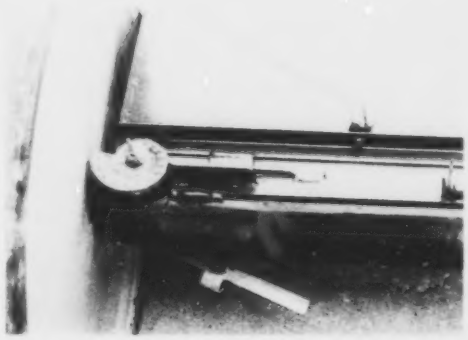
On the models designed for tractor mounting, the lever arrangement on the hopper is connected to a rope and pulley that extends up to the operator's position on the tractor.

As material flows downwards due to agitation by the rotor bars, it settles on the base plate and then flows out through the apertures in the base-plate. The streams of material are deflected off a wind-guard plate hanging from the front edge of the base plate, which spreads the streams of seed or granular fertilizer out so that they are deposited uniformly on the ground surface with minimal disruption by external forces such as cross-winds.

Each material spread, whether it is a different size of seed or a different type of granular fertilizer, will have its own flow characteristics and required application rate. Therefore a graduated cam gauge fitted into the slider plate mechanism acts as a variable stop, preventing the slider plate from moving beyond a pre-determined maximum aperture. Once the cam gauge is adjusted and set, the operator's hand control is only used to open or close the apertures.

Calibration using the cam gauge is a separate operation performed prior to the commencement of actual field spreading. The hopper is filled with the material to the spread, a calibration tray is suspended beneath the spreader openings, and the unit is moved along a measured distance at the same speed that will be used during actual spreading. The setting of the cam gauge is adjusted over subsequent calibration runs until the material collected in the calibration tray corresponds to the amount of material that should be distributed over the distance measured, at the desired application rate.

Note that the Gandy Model 604 can be ordered with the "Nursery Special" package. The modifications include a longer handle and a longer rotor-bar that allows the wheel centres to be adjusted to a maximum of 165 cm. The longer handle permits the operator to push the spreader while walking off to the side of the seedbed along the pathways. The variable wheel centres can be adjusted so that the wheels will run in the pathways between the seedbeds.



View of underside of a Gandy seeder showing apertures and calibration cam gauge.

**LIMITING FACTORS:**

1) The seed used must be dry. Moist latex used to pelletize seed tends to turn to mush and clog the openings at the ends and the centre of the hopper.

2) The care exercised by the operator during the calibration procedures is crucial to the overall accuracy of any seeding operation. Variations in operating speed, or delays in opening or closing the hopper slide, can cause improper calibration of the unit, which will result in inaccurate seeding rates in subsequent seeding operations.

3) The consistency of the application rate and distribution pattern diminishes as the level of material in the hopper drops below 2 kg. This factor makes the unit unsuitable for small seedlots.

## OPERATIONAL INFORMATION

**STAFF REQUIREMENTS:**

One person is required to operate most broadcast spreaders.

Other support personnel may assist in filling the hopper. Where the unit is mounted within a three-point hitch frame along with a roller packer and a bed-covering attachment, a second person often rides along on the frame. The operator on the frame controls the seed flow, keeps the hopper filled and keeps a close watch on the overall operation.

**OPTIONAL EQUIPMENT:**

**Gandy 600 Series**

1) Tractor hitch package includes hitching and seeder control hardware for operating a 600 Series spreader behind a tractor. Price $121.00.

2) Handle attachment package for all models currently set up for tractor operation. Converts 600 Series spreaders from tractor-drawn operation to hand operation. Price $90.00.

3) Dual rim wheel option includes additional wheels, spacer and mounting hardware for converting to dual wheels.

4) Bolt-on hole closures designed to block individual holes in the spreader metering mechanism.

5) Deflectors for side-dressing or banding.

6) Calibration pans available in lengths to fit all r

**Gandy 10T Series,**

1) Available in - front-mount models - three-point hitch models
- trailing-hitch models.

2) Wheel rims, 15 x 10 rims with 11L15 wide base tires to replace standard 15 x 5 rims and 6.70 x 15 ribbed implement tires and tubes.

3) Calibration pans available for all spreaders in the 10T series.

4) Clamp-on hole closures to cover individual holes in the metering mechanism.

5) Deflectors for side-dressing and banding.

6) Area coverage counter records the area covered by the spreader.

7) Hydraulic shut-off control.

8) Electric motor drive (12 volt) for front mounted spreaders. Used in place of the hydraulic drive.

9) Hand lever for slide control on the three-point hitch models.

10) Mounting brackets for front-mounting the spreaders on John Deere and International Harvester tractors.

**SPECIAL MODIFICATIONS:**

Several nurseries have mounted Gandy Model 604 spreaders within a heavy angle-iron frame along with a large corrugated drum, which serves as a seedbed packer and groover. The modified unit may also incorporate a set of bed-levelling bars.

**COMPLEMENTARY EQUIPMENT:**

When the Gandy spreaders are used for the broadcast seeding of nursery seedbeds the following items are normally used:

- bed-former
- groover/packer
- seed covering implement.

Some nurseries have incorporated these implements within a single frame so that all of the functions can be performed in a single operation.

**PRIME MOVER**

**TYPE:**

The 600 Series spreaders may be hand-operated or towed behind any standard agricultural tractor.

The 10T Series spreaders can be operated with any standard agricultural tractor.

**SAFETY ASPECTS:**

1) Standard safety precautions and procedures should be observed.

2) Operator(s) should be aware of all safe handling requirements associated with any fertilizers or seed-coating chemicals used.

**MAINTENANCE:**

Since these units receive light annual usage, approximately 4 hours annually for the spring and fall seeding operations at Kemptville, few mechanical problems are encountered.

**Daily** - Thoroughly clean the unit of all fertilizer or other chemical residues after each use to prevent corrosion and extend the life of the hopper.

- Remove the slide control and the rotor bars after each use to clean away any build-up of materials.

- During operation lightly grease bearings frequently to prevent fine particulate dust from working into the bearings and seizing the mechanism.

**Seasonally** - Coat all cleaned exposed metal surfaces with oil. Re-paint any scratches or chips in painted surfaces.

**PRODUCTION RATES:**

At Kemptville Nursery, a 1.2m Gandy spreader will on average seed 0.25 ha with approximately 3.5 million White and Norway Spruce seeds in one hour. Note that the actual production rate will vary considerably with a number of factors:

- tractor speed;
- calibration of the unit;
- model of spreader use;
- seed size.

**USERS' ASSESSMENT**

**ADVANTAGES:**

1) Utilizes the entire bed area more fully than a typical band seeder.

2) Very simple to set up and operate when compared to some of the band seeders or the newer vacuum seeders currently available.

**DISADVANTAGES:**

1) Seed tends to bounce from edges of the bed into the pathways, resulting in lost seed.

2) Wind may cause seed to be blown into the pathways or disrupt the uniformity of the seed distribution over the bed during the sowing operation.

3) Often seed must be encouraged to flow properly within the hopper by tapping the sides of the hopper. It is therefore necessary for the operator to keep a constant watch on the material being spread.

4) The flow of material from the hopper becomes erratic when the level of material in the hopper is low. A minimum of 2 kg of material must be maintained in the hopper to maintain consistent material distribution. The unit is not suitable for seeding with small seedlots.

5) Seed spacing is not as good as with band seeders.

**OPERATIONAL GROUP:**

**3** Sowing

**EQUIPMENT TYPE:**

**3.02** Band Seeders

**MAKES AND MODELS IN USE:**

1) J.E. Love Company,
   Love-Oyjord 16 twin-row seeder
2) Egedal, Model 83, band seeder

**MANUFACTURERS AND DISTRIBUTORS:**

1) J.E. Love Company Ltd.,
   Garfield, Washington
   99130 U.S.A.
   Telephone: (509) 635-1321
2) Egedal Maskinfabrik A/S,
   Egebjergevj 134,
   DK 8700 Horsens, Denmark
   Telephone: 45-5-656177
   Distributor: Timm Enterprises Ltd.,
   5204 Trafalgar Road,
   Oakville, Ontario
   L6J 4Z5
   Telephone: (416) 826-1333
   (416) 878-4244
   Telex: 06-982345

**CURRENT USERS AND NUMBER OF UNITS:**

| | |
|---|---|
| Chapleau | - |
| Dryden | 1 |
| Gogama | 1 Egedal model 83 |
| Kemptville | 1 |
| Midhurst | 1 |
| Orono | 1 * |
| St. Williams | - |
| Swastika | 1 * |
| Thessalon | 1 |
| Thunder Bay | 1 |

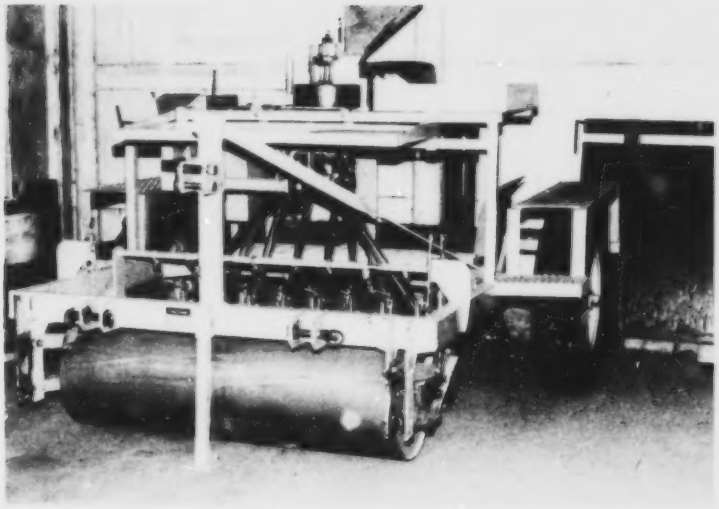
Note: All units are Love-Oyjord Seeders unless otherwise noted

* Seeder constructed by nursery staff. Oyjord metering system used.

**PRICE OF CURRENT MODELS:**

| | | |
|---|---|---|
| Oyjord Seeders | - 6-row | $ 15,000.00 |
| | - 7-row | $ 15,565.00 |
| | - 8-row | $ 16,125.00 |
| | - Sixteen twin | $ 25,000.00 |
| Egedal Seeder | - 6-row | $ 6,614.00 |
| | - 6-row | $ 7,288.00 |

Note: Egedal seeder prices F.O.B. Oakville, Ontario.



Oyjord seeder — Thunder Bay.

## TECHNICAL INFORMATION

**SPECIFICATIONS:**

**1) Love - Oyjord Seeder**

| | |
|---|---|
| Working Width | - 122 cm |
| Frame | - Welded structural steel tubing |
| Wheels | - 16 x 5.50F wheel on adjustable hubs<br>- 7.50 x 16 4-ply power implement tires<br>- Steel axle on bearing |
| Seed Bin | - Batch and bulk seed funnels |
| Seed Metering and Distribution | - Multi-port feeder head<br>- Spinner distributor<br>- Ground-driven steel roller chain drive. Permanently lubricated variable-speed drive coupled to a three-speed chain transmission with clutch and torque overload protection |
| Front Packer Roller | - 45.7 cm in diameter<br>- 121.9 or 106.7 cm long |
| Ground openers | - Double disc row openers<br>- Disc spacing 5 cm<br>- Carrier frames on 15.2 cm centres<br>- Flexible feeder tubes direct seed from the distributor |
| Packer Wheels | - Concave or flat<br>- Rear mount on carrier frames |
| Operators Platform | - Rear-mounted seat with steel decking |

**2) Egedal seeder**

| | |
|---|---|
| Working Width | - 110 cm |
| Total Width | - 170 cm |
| Height | - 115 cm |
| Frame | - Welded steel |
| Wheels | - 400 x 8 metric rims<br>- Tracgrip tires designed to maintain positive grip on the soil surface |
| Seed Bin | - Welded seamless plate steel construction<br>- Compartmentalized, one compartment per seed distribution unit<br>- Bin is equipped with 9 seed outlets allowing the connection of up to 9 sowing units |
| Seed Metering and Distribution | - Vertically oriented nylon finger wheels select seed for distribution<br>- Nylon flaps at seed orifices on the seed bin are adjustable to 10 positions to allow for different types of seed<br>- Chain driven from the right wheel<br>- Reversible and exchangeable gear cassettes for coarse adjustment<br>- A cone gearbox for fine adjustment of 160 different settings for correct calibration |
| Sowing Units | - Individual sowing units mounted independently along a height- adjustable bar<br>- Distance between units is fully adjustable<br>- Front and rear packer wheels incorporated into the carrie frames for each sowing unit<br>- Adjustable V-plough sowing share<br>- Telescoping seed transfer tubes |
| Operator's Platform | - None |

locations when not in use. Improper maintenance and storage can result in early wearing of the drive system and a build-up of rust and dirt that could jeopardize the precision of the seeding operations.

**Special maintenance equipment required** - None.

**Major repair items** - None identified.

**Ease of repair** - Very good; parts easily accessible.

**Parts availability** - Good.
Note: The J.E. Love Company does not have a Canadian distributor. Parts must be ordered from the manufacturer in Garfield, Washington, USA.

**PRODUCTION RATES:**
Highly dependent upon the seed being sown and the setting of the seeding calibration mechanism.

**USERS' ASSESSMENT**

**ADVANTAGES:**
1) Provides more control over the sowing operation than a simple broadcast seeder such as the Gandy seeder. The operator can set the number of rows, and make adjustments to meter the distribution of seeds along the rows.
2) Provides a much more uniform distribution of seeds than a simple broadcast seeder. This ensures better seedling growth because the seedlings have better spacing.
3) Can seed very small seed-lots with the same precise results as with larger seed-lots. Standard broadcast seeders are difficult to control as seed levels in the hopper become low.
4) Sowing is reduced to a single operation. There is no need for bed-rollers or seed-covering implements.

**DISADVANTAGES:**
1) Calibration procedures are more involved than those required by simple broadcast seeders.
2) The increased mechanical complexity requires more intensive maintenance.
3) The double disc coulter arrangement used to groove the soil in the Oyjord seeder may, depending upon soil conditions, cause extraneous soil fissures that result in deep seeding.
The Thunder Bay Nursery staff suggests using a raised bead on the seeder roller to create the grooves for seed placement.
4) The concave packing wheels available for the Oyjord seeder make it difficult to control seeding depth. The flat packing wheels are recommended.
5) The accurate metering of seed and the even spacing of the rows produced by band seeders result in a much better distribution of seedlings within a bed than does a broadcast spreader, but the distribution is still not optimum.
Modern vacuum seeders space seeds more evenly across the bed and along each row than can a band or a broadcast seeder.

**OTHER INFORMATION AVAILABLE:**
Dryden Tree Nursery is currently in the process of preparing a training video demonstrating proper calibration and operating procedures for the Oyjord Seeder. For more information contact the staff at the Dryden Nursery.

**OPTIONAL EQUIPMENT:**

**Oyjord band seeders:**

| | | |
|---|---|---|
| 1) Feeder divider package | $224.00 | - for bed lengths less than 10 feet. |
| 2) Vertical fluted feeder | $1072.00 | - for seed lots with more than 110,000 seed per kg and a low sowing density. |
| 3) Metering mechanism | | - for indoor laboratory calibrations.<br>- also used to modify other seed drills. |
| 6-row | $4,304.00 | |
| 7-row | $4,314.00 | |
| 8-row | $4,325.00 | |
| 4) Row conversion packages. | | - use to convert 6, 7, or 8-row seeders into 3 or 4 rows. |
| Conversion | | |
| 6-row to 3-row | $123.00 | |
| 7-to 3-row | $569.00 | |
| 6-to 4-row | $569.00 | |
| 7-to 4-row | $642.00 | |
| 8-to 3-row | $607.00 | |
| 8-to 4-row | $163.00 | |
| 5) Large seed conversion package | $1,515.00 | |

**Egedal Band Seeder:**

Optional baffles are available to close off one or more of the sowing box outlets in order to reduce the number of seeding rows. Price currently not available.

**SPECIAL MODIFICATIONS:**

1) Operator's platform on Oyjord seeder enlarged to enable the operator to move around the seeder mechanism more easily. A cat-walk-like platform was extended across the rear and up and over the wheels along the sides of the machine. The old fenders were eliminated. (Dryden Tree Nursery)

**COMPLEMENTARY EQUIPMENT:**

1) Bed-former.
2) Hydromulcher.

**PRIME MOVER**

**TYPE:**

Standard agricultural tractor.

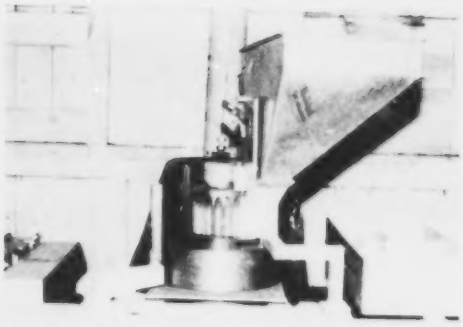
The Love - Oyjord seeder requires a tractor weighing a minimum of 1800 kg. Lighter tractors require front-end weights for balance.

**NET POWER REQUIREMENT:**

Minimum of 22.4 to 29.7 kw.

**ATTACHMENT:**

Three-point hitch.



Oyjord seed metering mechanism.

## TASK PERFORMED

Used for general spring and fall row seeding of full-scale nursery-beds and for seeding small individual seed-lots on short sections of seedbed.

## HOW IT WORKS

### WORKING PRINCIPLE:

Band seeders use a specially designed seed metering and distribution system to sow along a preset number of equally spaced rows.

### GENERAL DESCRIPTION:

The basic construction of a band seeder incorporates a seed hopper, a seed metering and distribution system and a series of individual sowing units.

The seed hopper maintains a supply of seed so that the seeder can be loaded and operated without continual attention by an operator. The hopper is normally a tapered box or is funnel- shaped to utilize gravity to direct a continuous flow of seed to the metering mechanism. Some makes, such as the Oyjord design, can use several exchangeable hoppers and optional attachments to accommodate different sowing requirements and seed characteristics.

The seed-metering mechanism accurately controls the flow of seed from the hopper to the sowing units. The Egedal seeder utilizes a series of rotating nylon finger wheels to transport small groups of seed through nylon flaps at the base of the seed bin. Telescoping distribution tubes then carry the seed to the sowing units.

With the Oyjord system, several optional metering mechanisms are available. For most softwood tree species, a vertical fluted feeder attachment is used. Seed flow from the hopper is controlled by a variable aperture opening at the base of the hopper and by the rotating fluted feeder drum. Seed only flows when one of the vertical grooves in the drum aligns with the hopper opening. Short pulses of seed from the fluted feeder fall onto an inverted cone, which distributes the seed around a slotted feeder wheel. The seeds settle into the slots arranged radially around the center of the wheel. As the plate rotates, individual slots pass over a single opening in a plate beneath the feeder wheel. The seed in each slot falls through the opening in turn. The metered stream of seed from the feeder plate orifice falls into the distribution head, where it is deflected off a rotating spinner within the head and directed into one of a series of chutes around the base of the head. Each chute is connected to a flexible tube leading to a sowing unit.

The seed metering and distribution systems utilized by these band seeders rely on complex arrangements of gears, chain drives, shafts, and pulleys to synchronize the moving parts. This allows the system to be calibrated to meet different seeding requirements.

Driving power is obtained from the hub of the seeder wheels. This arrangement maintains a more uniform seed distribution by speeding or slowing the seeder mechanism in conjunction with any change in the ground speed of the seeder.

Transmissions incorporated into the drive system permit both coarse and fine calibration adjustments. A clutch built into the system gives the operator control over the starting and stopping of the unit and also protects the seeder in the event of a jam.

Each sowing unit plants a single row of seeds by preparing the seedbed, opening a groove, depositing seeds along the groove, and then covering the seeds. The units are normally mounted independently onto the seeder frame so that each unit can respond individually to small undulations in the seedbed.

The seedbed is prepared by a roller or rollers, which pack the soil so that a clean groove can be cut into the bed. The Oyjord system uses a single large roller that extends across the full width of the seedbed and is independent of the sowing units. The Egedal incorporates small prepacking rollers into each sowing unit.

To groove the bed the Egedal utilizes a V-plough-type share. The Oyjord uses a system of double discs angled and oriented to produce a clean groove.

Seed is deposited into the groove by the distribution tube mounted behind the groover. The seed is then covered and packed by trailing packing wheels, common to both seeders.

The packing action improves the soil moisture retention.

**LIMITING FACTORS:**

1) Band seeders do not operate efficiently under inclement weather conditions such as wind and rain. Wind tends to blow the light-weight seed out of the funnel on the metering mechanism, upsetting the accuracy of the metering function. Excessive moisture causes the soil to stick to the rollers and the various seed-covering mechanisms, causing major disruptions of the seedbed.

2) The greater the number of seedlots to be seeded the more delays there are in the operation of the unit.

3) Often implements such as bedformers and hydromulchers are used in conjunction with precision seeders. All three operations should progress at approximately the same pace. If any single operation is delayed due to malfunction, all operations are similarly delayed.

4) The presence of stones and sticks in the soil can cause delays due to jamming or plugging of the sowing units.

5) Improper calibration prior to actual seeding can cause unnecessary delays and may lead to undesired seeding results.

## OPERATIONAL INFORMATION

**STAFF REQUIREMENTS:**

**Tractor driver** - One person is required to oversee the seeder operation and maintain the supply of seed in the seeder hopper.

Note: The Egedal seeder is not equipped with a position for an operator. The operator's function is performed by the tractor operator or other support personnel.

**Support** - Other support personnel may be employed to maintain the supply of seed to the operator as required.

**SAFETY ASPECTS:**

1) The operator should not wear loose clothing and should keep all appendages clear of any moving parts. All chain and pulley guards should be in place.

2) Standard safety procedures for working with and around agricultural machinery should be observed.

**MAINTENANCE:**

The complexity of the drive system requires particular attention. Prior lubrication and maintenance of all chains, gears, and bearings will ensure reliable and accurate seeding results.

The manufacturers of these two implements supply a recommended maintenance program.

The complexity and the need to maintain seeding accuracy necessitates that these band or drill type seeders be stored in clean, dry

**OPERATIONAL GROUP:**

**3** Sowing

**EQUIPMENT TYPE:**

**3.03** Hydromulchers

**MAKES AND MODELS IN USE:**

1) Finn, Models T80T
Bantam 500
BUHS

2) Bowie, Model 800

**MANUFACTURERS AND DISTRIBUTORS:**

1) Finn Equipment Company,
P.O. Box 8068,
2525 Duck Creek Road,
Cincinnati, Ohio
45208 U.S.A.

Distributor: Vermeer of Canada Ltd.,
3390 Wolfdale Road,
Mississauga, Ontario
L5C 1W4

Telephone: (416) 277-3608

2) Bowie Industries Inc.,
P.O. Box 931,
Bowie, Texas
76230 U.S.A.

Telephone: (817) 872-2286

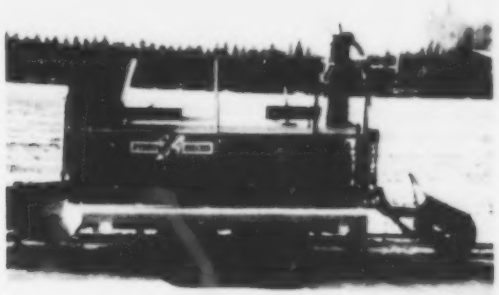
Distributor: Albion Seed Ltd.,
P.O. Box 492,
Bolton, Ontario
L0P 1A0

Telephone: (416) 857-6732

**CURRENT USERS AND NUMBER OF UNITS:**

| | | |
|---|---|---|
| Chapleau | — | |
| Dryden | 1 | |
| Gogama | — | |
| Kemptville | 1 | |
| Midhurst | 1 | |
| Orono | 1 | |
| St. Williams | 1 | (Bowie) |
| Swastika | 1 | (Bowie) |
| Thessalon | — | |
| Thunder Bay | 1 | |

Note: All are manufactured by Finn Equipment Corp. unless otherwise noted.



Hydromulcher — Swastika Nursery.

## TECHNICAL INFORMATION

### SPECIFICATIONS:

**Finn Model T80T**

| | |
|---|---|
| Length | - 437 cm |
| Width | - 208 cm |
| Height | - 218 cm |
| Weight | - (empty) 1587 g<br>- (loaded) 5216 g |
| Tank Capacity | - 3637 L |
| Trailer | - (GVWR) 7300 g |
| Power Source | - Wisconsin WH4D four-cylinder gasoline engine |

### OPTIONAL EQUIPMENT:

1) Nursery-bed attachment.

2) Various spray nozzles.

### SPECIAL MODIFICATIONS:

A minor change of the hitch from a hook and eye to a standard draw-bar-type hitch. (Orono Nursery)

## PRIME MOVER

### TYPE:

Standard agricultural tractor.

### NET POWER REQUIREMENT:

Minimum of 30 kw.

### ATTACHMENT:

Standard draw-bar hitch.

## TASK PERFORMED

Hydromulchers are used for mulching newly seeded nursery beds, to increase soil moisture retention, and to protect the beds from wind erosion.

## HOW IT WORKS

### WORKING PRINCIPLE:

Mulch materials are mixed with water to produce a slurry. The following property of water is utilized to spread an even mat of mulch over the seeded nursery beds.

### GENERAL DESCRIPTION:

The Finn hydromulcher is a 3637 L slurry tank mounted on a heavy-duty, dual-axle trailer frame. The trailer is equipped with standard 36 cm rims and pneumatic rubber tires suitable for road travel.

Functional power is provided by a self-contained four-cylinder gasoline engine rated at 22 kw. The engine powers a rotary slurry pump and a hydraulic system that operates a dual-action agitator inside the tank.

Mounted above and to the right of the engine is the operator's platform. The high position of the platform provides excellent visibility and allows the operator to continually monitor the progress of the mulching

Hydromulcher in operation.

operation.

Controls for the engine, agitator, slurry pump, and recirculation system are all readily accessible from the operator's position.

A slurry pump located directly below the operator's platform provides the pressure required to keep the mulch-water slurry circulating within the tank. The operator controls the flow from the pump so that it can be directed up through an 8 cm pipe to a spray nozzle located at the rear of the machine.

For nursery-bed mulching, the spray nozzle is pointed downwards to direct the mulch flow onto the nursery-bed mulching attachment, a fan-shaped steel plate mounted on the back of the mulcher. The plate is angled back from the machine and fans out to the width of the seedbed. When the slurry is sprayed onto the plate it is directed by two adjustable baffles to form an even sheet across the plate. The sheet of mulch then flows down the plate and is deposited onto the seedbed as the mulcher is pulled along by the tractor.

**LIMITING FACTORS:**

The hydromulcher follows the seeder and bed-covering units. The speed of the seeding operation may in some cases limit the mulching operation.

## OPERATIONAL INFORMATION

**STAFF REQUIREMENTS:**

**Operator** - One person is required to control the hydromulcher functions and generally acts as the crew leader.

**Support** - One tractor driver is required to manoeuvre the hydromulcher along the seedbeds and between nursery compartments.

**SAFETY ASPECTS:**

The operator should wear gloves, workboots and ear protectors.

**MAINTENANCE:**

**Daily** - Clean the unit after each use to prevent a build-up of residual mulching materials and to prevent corrosion caused by any chemical residues. Lubricate immediately after washing.

- Check engine oil, air filter, and hydraulic system.

**Every 40 Hours**
- Change engine oil.
- Adjust clutch and belt tension.
- General lubrication.
- Remove any residue remaining in the tank.

**Every 80 hours** - Change the oil filter.

**Every 100 hours** - Disassemble the discharge value, clean and check.

Manufacturers recommend a series of winterizing and post-season storage procedures to minimize the effects of storage and cold winter temperatures.

**PRODUCTION RATES:**

The Finn T80T will discharge a single tank (3637 litre) of mulch slurry over 0.1 ha of seedbed in approximately 15 minutes.

At Orono Nursery mulch is applied at a rate of 635 kg/ha.

Note: The slurry mixture used is 63.5 kilograms of Fibra-mulch to 3637 litres of water.

Nursery bed mulching attachment.

## USERS' ASSESSMENT

### ADVANTAGES:

1) Labour saving - only requires two people to operate. Old manual mulching methods required a large crew of labourers.

2) Quality control - the thickness of the mulch layer is much easier to control and maintain than with old manual methods or methods using mechanical sand and sawdust spreaders.

### DISADVANTAGES:

None noted.

**OPERATIONAL GROUP:**

**3** Sowing

**EQUIPMENT TYPE:**

**3.04** Sander/Mulch Spreader

**MAKES AND MODELS IN USE:**

All of the units currently in use have been fabricated by Ministry staff.

**CURRENT USERS AND NUMBER OF UNITS:**

| | |
|---|---|
| Chapleau | — |
| Dryden | — |
| Gogama | 1 |
| Kemptville | — |
| Midhurst | 1 |
| Orono | — |
| St. Williams | — |
| Swastika | 1 |
| Thessalon | 1 |
| Thunder Bay | — |

Sander/Mulcher #2 at Swastika Nursery.

**TECHNICAL INFORMATION**

**SPECIFICATIONS:**

| | |
|---|---|
| Maximum Length | -478 cm |
| Maximum Height | -163 cm |
| Bin: | |
| Width | -206 cm |
| Bottom Width | -30 cm |
| Length | -292 cm |
| Platform: | |
| Length | -292 cm |
| Width | -48 cm |
| Spreader Disc: | |
| Diameter | -50 cm |
| No. Fins | -4 to 6 |
| Feed Belt: | |
| Width | - 25 to 30 cm |
| Miscellaneous: | |
| Wheels | - 55 cm rims |
| Tires | - Goodyear nylon 12-ply. |

**COMPLEMENTARY EQUIPMENT:**

1) A tractor with a hydraulic bucket may be used to load the hopper with sand.

2) A bed roller is used to pack the sand layer after it has been spread over the seedbed.

## PRIME MOVER

**TYPE:**

Standard agricultural tractor.

**NET POWER REQUIREMENT:**

Minimum of 37 kw.

**ATTACHMENT:**

Draw-bar attachment.

## TASK PERFORMED

Used to spread an even layer of sand over the seedbed to protect the newly sown seed from wind erosion and from excessive drying during the crucial stages of germination.

## HOW IT WORKS

**WORKING PRINCIPLE:**

A metered stream of sand is poured onto a rotating distribution disc which has vertical fins attached to its upper surface. The sand is captured by the vertical fins and is subsequently thrown outwards from the disc by centrifugal force. The spreading action deposits an even layer of sand along the bed surface as the unit progresses along a seedbed.

**GENERAL DESCRIPTION:**

The sand spreader consists of a large hopper equipped with a material transport, and distribution mechanism.

The hopper is rectangular and narrows towards its base. The bottom of the hopper is occupied by the transport mechanism, consisting of either a chain conveyor or two augers placed side by side.

The material in the hopper is fed by gravity to the base of the hopper. The sloping side-walls of the hopper funnel the material onto the transport mechanism, which, in turn, moves the material to an opening at either the front or the rear of the hopper, depending upon the design of the unit.

The flow of material is controlled by an adjustable sliding trap door over the opening. The speed of the transport mechanism and the size of the adjustable opening work to meter the material entering the distribution mechanism.

The distribution mechanism consists of a rotating disc and a deflection shield. The rotation of the disc is powered either by a mechanical connection to the PTO of the tractor or by a hydraulic motor on more recent versions.

The upper surface of the distribution disc is fitted with vertical fins radiating from the centre. As the sand falls onto the disc it is caught by the fins and driven out by centrifugal force until it is projected from the edge of the disc. The fins ensure that material is distributed evenly in all directions.

To prevent the sand from falling outside the seedbed an angled shield mounted around the distribution disc deflects the sand downwards over a swath approximately the width of the newly seeded bed surface.

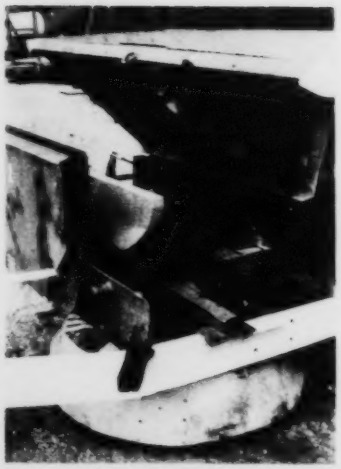
The spreader is towed by a draw-bar attachment to any standard agricultural tractor. The weight of the unit and the load of sand is supported by dual axles fitted with standard-implement-type pneumatic tires.

**LIMITING FACTORS:**

1) The loaded unit is quite heavy and limits the machine to use on relatively dry soils.

2) If the sand being spread is moist to the point of being slightly sticky, it tends to stick to the shield and fall off in clumps onto the seedbed rather than being evenly distributed.

3) The skill of the tractor operator at maintaining an even forward speed and the ability of the sander operator to properly adjust the flow of sand will determine the thickness and uniformity of the layer of sand.



Close up of the distribution mechanism showing the adjustable hopper door, the transport chain, and the deflection shield—Swastika Nursery.

## OPERATIONAL INFORMATION

**STAFF REQUIREMENTS:**

**Tractor**-One person is required to drive the tractor.

**Spreader**-One person is required to travel on the sander unit to make adjustments to the sand flowing to the distribution disc, to ensure that the sand is flowing evenly within the hopper and to monitor the distribution of sand to the bed surface.

**SAFETY ASPECTS:**

The tractor operator should frequently check back to the sander operator.

The sander operator should not wear loose clothing and must exercise caution to ensure that hands and feet do not become caught in the moving parts of the unit.

**MAINTENANCE:**

**Daily**-Grease and inspect moving parts.

**Seasonal**-Prior to storage at the end of the season, thoroughly clean, paint, grease and replace worn or damaged parts.

**Special Maintenance Equipment Required**-None.

**PRODUCTION RATES:**

One load = 1.53 $m^3$

One load = 2 average nurserybeds

(300 m of 1.22 m wide seedbed)

The unit can spread sand over an average of 60 beds in eight hours.

## USERS' ASSESSMENT

### ADVANTAGES:

1) Sanders are simple and inexpensive devices to fabricate and maintain.

### DISADVANTAGES:

1) Sand is sometimes deposited somewhat more heavily on the edges of the bed than across the centre portions.

2) Moist sand sticks to the deflection shield resulting in clumping of sand and uneven distribution of material.

3) Hydromulchers are more readily controlled and produce a more even and suitable mulch layer than is possible with the sander.

**OPERATIONAL GROUP:**

**3** Sowing

**EQUIPMENT TYPE:**

**3.05** Seedbed Groover/Roller

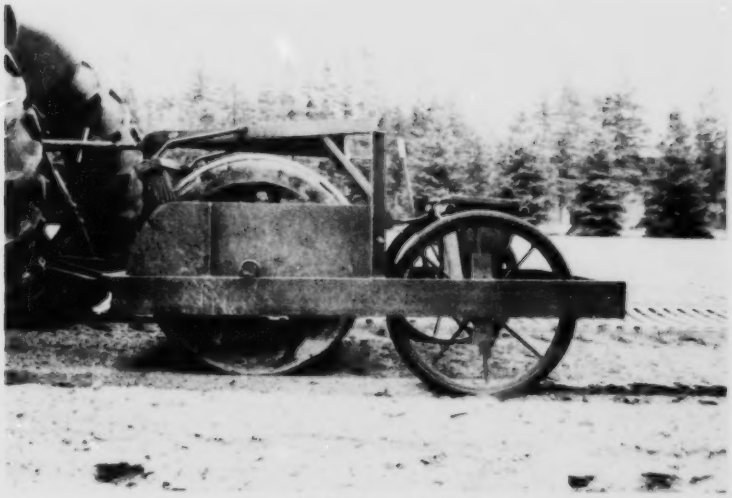
**MANUFACTURERS AND DISTRIBUTORS:**

All of the units currently in use have been fabricated by Ministry staff.

Most local welding shops are well enough equipped to fabricate similar implements.

**CURRENT USERS AND NUMBER OF UNITS:**

| | |
|---|---|
| Chapleau | 2 |
| Dryden | — |
| Gogama | 2 |
| Kemptville | 1 |
| Midhurst | 2 |
| Orono | 1 |
| St. Williams | — |
| Swastika | — |
| Thessalon | 1 |
| Thunder Bay | — |



Seedbed groover/roller in tandem with a broadcast seeder — Midhurst Nursery.

**TECHNICAL INFORMATION**

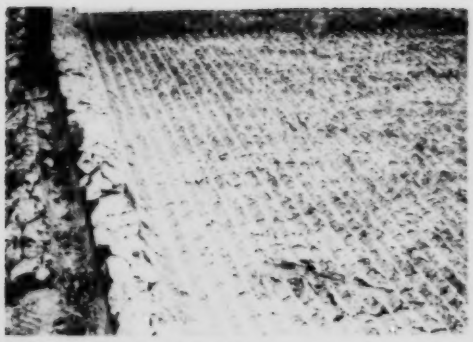
**SPECIFICATIONS:**

Frame
- 15 cm welded channel steel
- 183 cm long
- 157 cm wide

Drum
- 76 cm diameter
- 122 cm wide
- grooved drum fabricated from 2.54 cm or 1.9 cm angle iron bars, for use with large seed and small seed respectively

**SPECIAL MODIFICATIONS:**

Although the grooved roller can be built and operated as a single unit, it is often built into a frame along with a broadcast seeder and sometimes a seed-covering unit. This modification reduces these three separate stages in seeding to a single operation.



Close up of grooved seedbed.

**COMPLEMENTARY EQUIPMENT:**

1) Bed-former.
2) Broadcast seeder.
3) Bed covering unit.

## PRIME MOVER

**TYPE:**

Standard agricultural tractor.

**NET POWER REQUIREMENT:**

Minimum 22 kw.

**ATTACHMENT:**

Three-point hitch equipped with anti-sway bars.

## TASK PERFORMED

Seedbed groovers are used to groove and pack the seedbeds immediately preceding seed sowing.

Bed packing is important to improve soil moisture retention during the crucial germination stages.

Grooving leads to more uniform seed distribution and ensures that the seeds are sown at an optimum depth.

## HOW IT WORKS

**WORKING PRINCIPLE:**

A corrugated drum is rolled along the length of the formed seed-beds just prior to seeding. The weight of the roller packs the soil slightly and impresses a pattern of ridges and grooves into the bed surface.

**GENERAL DESCRIPTION:**

The grooved roller is a large corrugated drum mounted on an axle mounted across a frame that attaches to the three-point hitch of a tractor. The axle of the drum rotates on bearings attached to the side members of the frame.

The drum consists of a series of hoops fabricated from sections of angle iron that have been bent into a circular form so that the angled part of each bar points outwards around the circumference of the hoop. The hoops are welded side by side to form a grooved drum the same width as the nursery-beds. Steel spokes connect the drum to the axle at the centre of the drum.

The grooved roller may be modified to accommodate different seed types. For fine seed, such as the spruces, the drum is made from sections of 1.9 cm iron, which produces shallower 1.27 cm deep grooves. For larger seeds such as the pines and some of the hardwood species the drum is made from 2.54 cm angle iron and produces bed grooves of 1.9 cm depth. When the grooves are levelled out by the bed levelling or seed covering unit, the use of the proper groove depth ensures that the seeds will be covered with the optimum depth of soil for the promotion of germination.

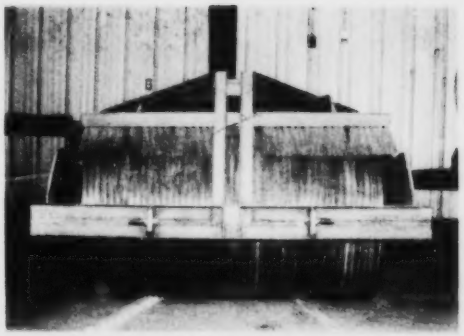
Often the frame is extended beyond the rear of the drum to provide a mount for attaching a 1.2 m broadcast seeder and in some instances a seed-covering attachment.

Since the frame is connected to the three-point hitch, the tractor hydraulics may be utilized to raise the unit, for transport and maneuvering at the end of each bed, and to lower it during normal operation so that the weight of the unit is carried by the roller.

Anti-sway bars are installed on the three-point hitch to maintain stability and centre the unit on the seed-bed. The additional rigidity of the mount ensures that the grooving and seeding operations will track in a straight line along the seed-bed without swaying into the pathways.

A platform above the drum serves as an operator's position or a place to add additional weight above the roller to improve packing and grooving. When the frame encloses a seeder, the operator of the seeder and a supply of seed can be stationed on the platform. The operator monitors progress, maintains the supply of seed in the seeder, and serves as ballast for the roller.

In order to prevent a build-up of soil and debris in the grooves of the drum a heavy bristled brush is rigidly mounted on two brackets beneath the platform so that it scrubs against the drum. As the drum revolves, the brush cleans the grooves of the drum to maintain optimum grooving conditions.



Front view of the corrugated drum showing the cleaning brushes and three point hitch mount.

**LIMITING FACTORS:**

1) Soil Moisture - If the soil is too dry the ridges and grooves will crumble and not form properly. If the soil is too wet, it will stick to the drum and disrupt the proper formation of the grooves. The soil moisture levels that facilitate proper formation must be determined by trial and error.

2) Associated Operations - Other operations such as seeding that have been incorporated into the design of the grooved rolling unit reduce the speed of the overall grooving operation.

## OPERATIONAL INFORMATION

**STAFF REQUIREMENTS:**

One person is required to operate the tractor.

Since the unit can be operated with the Gandy broadcast seeder installed, a second operator may ride on the unit to operate the seeder.

**SAFETY ASPECTS:**

Standard agricultural safety practices.

**MAINTENANCE:**

**Daily**-Clean soil and debris from unit after each use.

**Weekly**- Grease the drum bearings on either side of the frame.

**Seasonally** -Thoroughly clean the unit.
- Re-paint the frame if required.
- Oil the drum to prevent the formation of rust.

**Major Repair Items** — None.

**Special Repair Equipment** — None. All repairs, modifications, or maintenance can easily be performed by a modestly equipped nursery shop.

## USERS' ASSESSMENT

### ADVANTAGES:

1) Different rollers can be fabricated to meet the requirements of different types of seed.

2) The current design of the unit facilitates the incorporation of several related implements into one. This simplifies sowing by reducing the number of equipment passes required and saves time.

### DISADVANTAGES:

1) The seeds do not always fall to the bottom of the grooves. One purpose of the grooves, which is to help even out the distribution of the seeds across the seedbed, much like a band seeder, is not always achieved.

2) Because the roller is a single unit across the full bed-width, it is not responsive to small undulations across the bed surface. The proper formation of grooves will be hindered by small hummocks and depressions in the bed surface.

**OPERATIONAL GROUP:**

**3** Sowing

**EQUIPMENT TYPE:**

**3.06** Seed Covering Unit

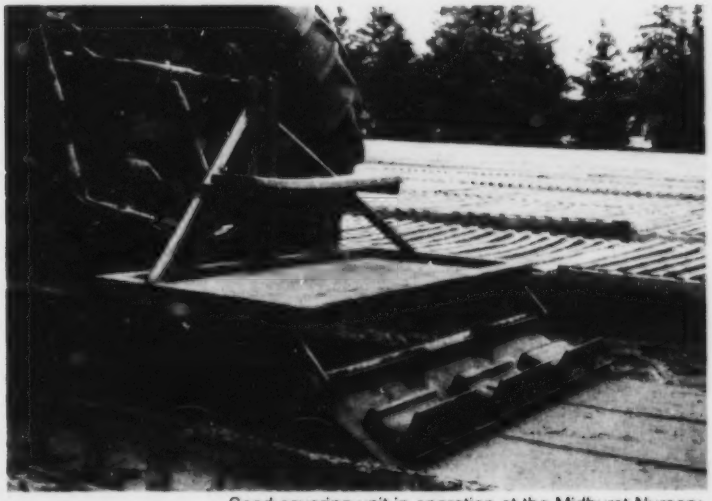
**MANUFACTURERS AND DISTRIBUTORS:**

All seed-covering units in use at Ontario tree nurseries have been fabricated by Ministry staff at the nurseries.

**CURRENT USERS AND NUMBER OF UNITS:**

| | |
|---|---|
| Chapleau | — |
| Dryden | — |
| Gogama | — |
| Kemptville | 1 * |
| Midhurst | 1 |
| Orono | — |
| St. Williams | — |
| Swastika | — |
| Thessalon | — |
| Thunder Bay | — |

* Note: The seed-covering unit is part of a multi-function seed-sowing implement. See section 3.05, Seedbed Groover/Roller.



Seed covering unit in operation at the Midhurst Nursery.

**TECHNICAL INFORMATION**

**SPECIFICATIONS:**

The following dimensions, typical of the units in use, apply to the seed-covering unit in use at the Midhurst Nursery.

| | |
|---|---|
| Overall Width | - 122 cm |
| Section Width | - 41 cm |
| Platform: | |
| Length | - 61 cm |
| Width | - 127 cm |
| Materials: | |
| Platform | - 5 cm channel iron |
| | - 1.9 cm plywood |
| Hitch | - Welded steel bar-stock |

| | |
|---|---|
| Hinge | - Solid round steel bar, 2.5 cm diameter and 127 cm long |
| | - 3 sections of steel pipe, 28.6 mm I.D. and 41 cm long |
| Drags | - 3 sections of 25 cm channel iron |
| | - 5 cm channel depth |
| | - 6.4 mm wall thickness |
| | - each section 41 cm long |

**SPECIAL MODIFICATIONS:**

At Kemptville Nursery, the seed-covering unit has been incorporated into a multi-function seeding implement with a grooved roller, and a 1.2 m broadcast seeder. The seed-covering unit is mounted along the rear edge of the implement frame.

**COMPLEMENTARY EQUIPMENT:**

1) Beuformer.
2) Seed-bed groover.
3) Broadcast seeder.

**PRIME MOVER**

**TYPE:**

Standard agricultural tractor.

**NET POWER REQUIREMENT:**

22 kw.

**ATTACHMENT:**

Three-point hitch.

**TASK PERFORMED**

The unit is used to cover seed with a thin layer of soil following bed grooving and seed spreading in spring and fall seed operations.

**HOW IT WORKS**

**WORKING PRINCIPLE:**

Several smooth steel plates are dragged along previously grooved and seeded nursery-beds. The angle at which the plates contact the ground and the weight of the plates cause a combination of both ploughing and crushing forces to be applied to the soil ridges left by the bed groover. As a result, the soil ridges are levelled out over the seeds spread along the grooves in the seedbed.

**GENERAL DESCRIPTION:**

The seed-covering unit consists of three heavy steel plates (drags) mounted side by side on a hinge. Together, they stretch across the width of the seedbed. The hinge is mounted along the rear edge of a

platform suspended from the three-point hitch of a standard agricultural tractor.

Prior to operation the unit is adjusted to suit the soil texture and moisture conditions. With the rear edge of the drags touching the ground the three-point hitch is raised or lowered to change the angle of the plates. The higher the platform, the steeper the angle of the drags to the ground. For coarse, heavy or wet soils the angle is normally steep. For dry, light soils the angle is usually shallow.

The unit is passed along the length of a seedbed that has just been grooved and seeded. The drags crush the ridges left by the ridged roller and push some of the soil forward so that it fills the grooves.

Three drag sections are used across the bed width in order to improve the flexibility of the unit. If a small hummock or depression is encountered in some section of the bed, each drag section can swivel up or down on its hinge attachment without affecting the operation of the other sections. This minimizes scalping of hummock areas and the tendency for depressions to remain uncovered after a pass.

**LIMITING FACTORS:**

1) If the soil is too dry the ridged roller will not form the ridges properly, which affects how well the covering unit can perform its duty without interfering with seed placement.

If the soil is too wet the soil may stick to the ridged roller, creating poor ridges and grooves in the bed, which will affect the ability of the unit to properly cover the seed. Soil generally does not level out well when it is wet and sticky.

## OPERATIONAL INFORMATION

**STAFF REQUIREMENTS:**

One person is required to drive the tractor and make appropriate adjustments to the height of the implement as required.

One person may be stationed on the platform of the unit to observe the covering operation and notify the tractor operator if adjustments are required. On the multi-function version of this implement, the person maintaining the seed supply of the seeder also watches the covering.

**SAFETY ASPECTS:**

Standard safety practices pertaining to the operation of agricultural machinery should be observed.

**MAINTENANCE:**

The unit is of a very simple design with few moving parts and requires very little maintenance.

**Seasonally** - Clean and oil.

**PRODUCTION RATES:**

In normal operation the unit can cover a field area of approximately 0.81 ha/hour.

## USERS' ASSESSMENT

### ADVANTAGES:

1) The version of seed-covering unit that operates as a separate unit provides more control over the seed-covering operation. The multi-function version does not easily permit raising or lowering of the drags to meet varying soil conditions.

### DISADVANTAGES:

1) The independent version of the seed-covering unit requires an additional implement pass along the seedbed to cover the seed. The multi-function version completes all functions in a single pass and therefore saves time and labour.

**OPERATIONAL GROUP:**

**3** Sowing

**EQUIPMENT TYPE:**

**3.07** Hardwood Seeder

**MAKES AND MODELS IN USE:**

Climax Universal Sowing Machine, Model UZA

**MANUFACTURERS AND DISTRIBUTORS:**

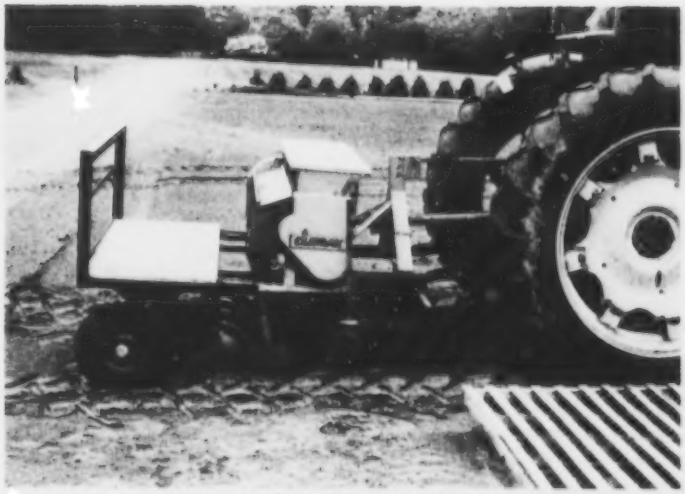
1) Zijlstra and Bolhuis B.V.,
Beeneden Dwardsdiep 25,
P.O. Box 42,
Netherlands

Telephone: (05987) 15970

Telex: 77250

Distributor: Jake Kloosterman Equipment Ltd.,
Hwy. 89 West,
Alliston, Ontario
L0M 1A0

Telephone: (705) 435-4220



Climax hardwood seeder—St. Williams Nursery.

**CURRENT USERS AND NUMBER OF UNITS:**

| | |
|---|---|
| Chapleau | — |
| Dryden | — |
| Gogama | — |
| Kemptville | — |
| Midhurst | — |
| Orono | — |
| St. Williams | 1 |
| Swastika | — |
| Thessalon | — |
| Thunder Bay | — |

**PRICE OF CURRENT MODELS:**

Price varies with changes in exchange rate between Canada and the Netherlands.

In 1986 the price of a five-row seeder, delivered to Orangeville, Ontario was $8,588.00.

## TECHNICAL INFORMATION

### SPECIFICATIONS:

| | |
|---|---|
| Working Width | - 100 cm |
| Seed Hopper | - 28 cm front to back |
| | - 122 cm side to side |
| | - Maximum depth 36 cm |
| | - Tapering to base |
| Distribution System | - 23 cm rotating concave plate |
| | -Vertically rotating rubberized flipper wheel; four flippers per wheel; two wheels associated with each distribution plate |
| | - Aluminum seed drop tubes 4 cm in diameter. Standard on stock unit |
| Sowing Units | - V-plough bed-grooving share |
| | - Depth control roller |
| | 20 cm diameter |
| | 8 cm wide |
| | - Packing roller |
| | 10 cm diameter |
| | 5 cm wide |
| | - Covering devices. Trailing sections of angled steel rod with adjustable weights; 2 per sowing unit |
| Frame | - Welded steel tubing |
| Wheels | - Two pneumatic 4.0 x 8.0 6 ply tires |
| Operator's Position | - Rear-mounted seat |

### OPTIONAL EQUIPMENT:

A spreader plate is available to convert the unit into a regular broadcast spreader.

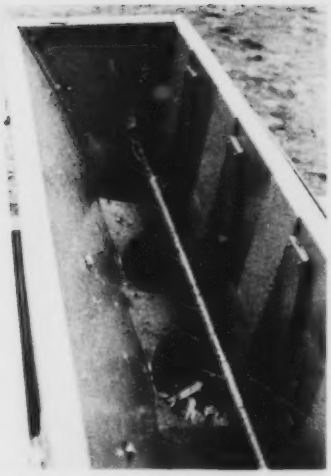
### SPECIAL MODIFICATIONS:

Seed-covering mechanism improved by installing angled sections of iron bar, 10 cm in length, at the end of each trailing covering rod.

Diameter of the seed drop tubing increased to 8 cm I.D. aluminum tubing to better facilitate the unrestricted flow of winged hardwood seeds.

Six vertical studs added to each feed plate to keep the flat winged seeds typical of some hardwood species from bunching up and jamming before they reach the flipper wheels.

Operator's seat removed and replaced with a 61 x 122 cm platform mounted on the rear of the unit. The platform allows the operator to move around for better access to seed-feeding mechanisms. It also enables the operator to carry a supply of seed on the unit while in operation.



View inside the seed hopper showing the rotating concave dishes.

Close up view of the rear of the seeder showing the viewing shutes, the enlarged droptubes and the right sowing unit.

The groups of seed subsequently enter a distribution viewing chute and then descend through a seed-drop tube, each of which leads to a single sowing unit.

Each sowing unit is independent of the others and seeds a single row. Each sowing unit incorporates a front-mounted depth-setting wheel that rides along the bed surface to raise or lower the unit in response to undulations in the bed. This ensures that the bed-grooving share will be maintained at the optimum seed-sowing depth.

Seed is released from the drop tubes just behind the grooving share so that it is deposited into the bottom of the groove. A packing wheel presses the deposited seed into the base of the groove. The groove is then covered with soil by two angled drags that pull the soil back over the groove.

The Climax Universal seeder requires an external power source. A shaft from the tractor's rear PTO shaft connects to a V-belt pulley. A long belt travels from the PTO shaft around two pulleys on the left side of the frame, where it twists ninety degrees to a pulley on the side of the bin. The side-mounted pulley connects with a chain drive that rotates two shafts that extend across the width of the seeder. One shaft turns the feeding dishes with worm gear assemblies. The second shaft drives the flapper wheels.

**LIMITING FACTORS:**

1) Wet soil will stick to the sowing units and reduce the efficiency of the seed-covering drags.

2) Large seeds, particularly those with seed-wings, tend to plug the seed drop tubes and do not flow well in the hopper. The modifications mentioned above have helped alleviate this problem.

With large winged seeds like silver maple, the unit operates most efficiently when the operator feeds only a small amount into the bottom of the hopper at one time, generally enough to fill the recessed concave dishes.

The metering mechanism is too coarse for use with fine seeds.

3) When sowing large seeds such as oak, the hopper tends to be small for the volumes of seed required.

## OPERATIONAL INFORMATION

**STAFF REQUIREMENTS:**

**Operators** - One person is required to ride on the sowing unit to maintain the supply of seed in the hopper and to ensure that the seed is flowing properly through the metering mechanism and distribution tubes.

A second person follows the unit to observe the quality of the sowing operation and supply seed to the operator as required.

**Driver** - One person operates the tractor in order to maintain the proper speed and ensure the beds produced are properly aligned.

**SAFETY ASPECTS:**

1) Caution should be observed when clearing the drop tubes during operation of the seeder. A poker made of stiff plastic hose is the safest means.

2) Although the unit is fitted with shields over most of the readily accessible moving parts, the operator should still keep hands away from the moving parts of the machine. Loose clothing should not be worn by the operator.

3) The PTO should be disengaged before servicing or repairs.

**MAINTENANCE:**

At the present time the unit is only used for one or two days per season, so required maintenance activities are minimal.

Grease all joints and moving parts.

At the end of the season, thoroughly clean the unit and store in a clean dry location to prevent rust formation.

**Special maintenance equipment required** - None.

**Major repair items** - None.

**Ease of repair** - Very good.

**Parts availability** - Since the unit is not sold in high volumes in North America, parts must be ordered from the Netherlands. Most parts can be fabricated by local welding shops or by the nursery mechanics as required.

**PRODUCTION RATES:**

Planting five-row beds of silver maple, the unit can sow 1000 metres per hour. The seed is applied at a rate of eight to nine litres per 10-metre stretch of bed.

The actual production rates will vary in accordance with the type of seed being sown, the adjustment of the seeder, the speed of the tractor and the sowing characteristics required.

**USERS' ASSESSMENT**

**ADVANTAGES:**

1) Band seeding of hardwoods produces a bed that is much easier to cultivate and weed than similar broadcast-seeded beds.

2) The band seeder produces a better distribution of seeds within the seedbed. Seedbeds are sown with more seeds per unit area than broadcast-seeded beds. It is hoped that in the long run tree quality will be improved.

3) The band seeder saves on labour. Old broadcast seeding methods required one person to operate the V-plough, eight people sowing seed, and one person operating a reverse V-plough to cover the seeds. A crew this size could sow approximately the same amount of bed in the same time as the Climax five-row seeder with only three people.

**DISADVANTAGES:**

1) The unit has a tendency to plug when large winged seeds are being sown. The operator must pay constant attention to the flow of seed and not load the hopper too deeply.

The unit is still undergoing modifications in an attempt to alleviate these problems.

The three-point hitch was moved forward 8 cm to convert it for use with the three-point hitch configuration of North American tractors.

**COMPLEMENTARY EQUIPMENT:**

A length of flexible plastic hose was found to be a safe and handy means of unplugging seed drop-tubes while the unit is in operation.

## PRIME MOVER

**TYPE:**

Standard agricultural tractor.

**NET POWER REQUIREMENT:**

Minimum of 22 kw.

**ATTACHMENT:**

Three-point hitch.

## TASK PERFORMED

This implement is used for spring and fall seeding of hardwood species such as red oak, silver maple and white ash.

## HOW IT WORKS

**WORKING PRINCIPLE:**

A series of independently mounted sowing units is pulled along a prepared nursery bed. Each unit creates a shallow groove in the bed surface. A mechanism systematically deposits seeds into tubes which direct the seed into the grooves. The seeding units then pack and cover the deposited seeds with soil.

**GENERAL DESCRIPTION:**

The Climax Universal seeder is a four-, five-, or six-row seeding unit that was developed in the Netherlands in the early sixties for use in tree nurseries and in horticulture. Its design allows it to be used for spreading fertilizer and sand as well.

The unit consists of a wheeled frame that mounts to the tractor's three-point hitch. The wheels assist in maintaining an even seeding depth. The three-point hitch provides a stable and controllable mount that tracks the seeder rigidly behind the tractor and also allows the unit to be lifted for transport.

A steel hopper holds a supply of seed, which is directed by gravity to the seed metering mechanism at the base of the seed hopper.

The feeding and metering mechanism consists of a series of rotating concave dishes recessed into the base of the hopper. Each dish has six vertical lugs that agitate the seed to keep it moving towards the hopper bottom and the metering mechanism.

Seeds that fall onto the concave plates are carried around by the rotation of the plates and pulled under a shield over the rear portion of each plate. A pair of rotating rubber flapper wheels, behind the shield, extend down into the concave dish and flip seeds through an opening in the rear hopper wall. The metering action of the flapper wheels limits the seed to small groups of one to three seeds.

**OPERATIONAL GROUP:**

**4** Irrigation

**EQUIPMENT TYPE:**

**4.01** Truck-Mounted Pipe Carrier

**MANUFACTURERS AND DISTRIBUTORS:**

The unit described was constructed by Ministry staff at the Kemptville Nursery.

**CURRENT USERS AND NUMBER OF UNITS:**

| | |
|---|---|
| Chapleau | — |
| Dryden | — |
| Gogama | — |
| Kemptville | 1 |
| Midhurst | 1 |
| Orono | 1 |
| St. Williams | — |
| Swastika | — |
| Thessalon | — |
| Thunder Bay | — |

Truck-mounted pipe carrier—Kemptville Nursery.

**TECHNICAL INFORMATION**

**SPECIFICATIONS:**

| | |
|---|---|
| Length Closed | - 198 cm |
| Length Extended | - 335 cm |
| Outer Post Height | - 36 cm |
| Inner Post Height | - 56 cm |
| Distance, Outer-Inner Post | - 76 cm |
| Distance End of Bracket to Truck | - 137 cm |
| Materials | - Steel bar-stock |
| | - Steel tube stock |
| | - Welded |

**COMPLEMENTARY EQUIPMENT:**

Standard swing-away truck mirror mounted on the front edge of the driver's side front fender. Because the driver is enclosed within the truck cab he or she has a limited view of the position of the wheels with respect to the nursery-bed. The mirror permits the driver to align the truck with the seedbed more accurately.

## PRIME MOVER

**TYPE:**

One half or three-quarter-ton four-wheel-drive pickup with a heavy-duty suspension.

**ATTACHMENT:**

Brackets mount to the front and rear bumpers.

## TASK PERFORMED

Used from April to September, for transporting irrigation pipe from the pipe storage area to the fields and between fields.

## HOW IT WORKS

**WORKING PRINCIPLE:**

Telescoping racks extend out to the side of a standard pickup truck allowing it to carry lengths of aluminum irrigation piping.

**GENERAL DESCRIPTION:**

Steel brackets bolted to both the front and rear bumpers of a standard pickup serve as the mounts for two telescoping racks which can be extended out from the side of the truck.

The steel racks are approximately the same length as the truck's width. Each rack has two vertical posts, one at the very end of the main horizontal portion to prevent the pipe from falling off the end of the racks, and one mounted about 76 cm in from the outer post to keep the pipe sections from rolling inwards.

The bumper brackets are designed with an open channel into which the main horizontal bar of the rack fits. The channel has flanges that hook over the horizontal bar of each rack in such a way that the rack is able to telescope in and out from the bumper, while still maintaining sufficient strength to support the weight of a stack of the pipe sections.

During normal operation of the truck the racks are pulled in completely. Safety pins inserted in the brackets ensure that the racks will not accidentally extend.

When pipes are to be transported the safety pins are removed and the racks fully extended. The pins are re-inserted to lock the racks in the extended position.

The width at full extension has been designed to position the load of pipe sections one pathway over from that in which the right wheels of the truck are operating .

Close-up showing bumper mount and the telescoping extension mechanism.

**LIMITING FACTORS:**

If vehicle suspension is too light the truck will tilt excessively to one side due to the weight of the pipe.

Because of the characteristic low ground clearance of pickup trucks, some nursery stock may not easily pass under the truck without rubbing on the underside of the truck.

## OPERATIONAL INFORMATION

**STAFF REQUIREMENTS:**

**Operator** - One person is required to drive the pickup.

**Support** - Two people load and unload pipe from the pipe rack extensions.

**SAFETY ASPECTS:**

The driver must exercise extreme caution when driving a load of pipes around the nursery. With a load of pipe the truck becomes considerably wider so that extra leeway must be allowed for the passage of other oncoming vehicles on the nursery roadways.

The driver must also be aware of the location of all personnel so that no one will accidentally be caught by the long wide load during a turn.

**MAINTENANCE:**

Inspect regularly for wear or cracks of the steel racks.

Repair or replace as required.

**Special maintenance equipment required** - None.

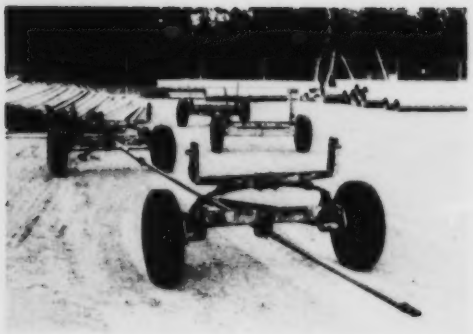
**Major repair items** - None.

**Ease of repair** - Excellent.

**Parts availability** - Very good (shop-fabricated as required.)

**PRODUCTION RATES:**

A single load on a pickup with a heavy duty suspension can hold up to 16 lengths of 9.1m aluminum pipe sections. This is generally enough to lay a single length of pipe along a normal sized nursery compartment length of 150 m.



Standard pipe wagon—Midhurst Nursery.

## USERS' ASSESSMENT

### ADVANTAGES:

1) The pickup and layout crew can ride safely on the pickup while travelling with a load of pipe between compartments or en route from the pipe storage area. This is much safer and more convenient than having them ride on a loaded pipe wagon or travel in a separate vehicle.

2) This self-contained single unit can be ready for use at any time. It does not rely upon setting up a tractor and trailer combination.

3) Simple and convenient loading and unloading. The unique side-mount design places the rack directly over the pathway in which the pipe is being laid or from which it is being retrieved. The truck is positioned out of the way over the adjacent nursery-bed. This arrangement allows the two pipe-handlers to easily lay pipe by simply sliding the sections of pipe off the rear end of the rack one at a time as the pickup slowly advances along the bed. The pickup of pipe is equally simple. The sections of pipe are simply slid up onto the front of the rack as the unit progresses.

### DISADVANTAGES:

None noted.

**OPERATIONAL GROUP:**

**5** Fertilization and Soil Amendments

**EQUIPMENT TYPE:**

**5.01** Pneumatic Spreaders

**MAKES AND MODELS IN USE:**

1) Amazone Jet, Model 801, 802
1201
1502

Note: The model 800 line has been discontinued. Beginning in 1988 the current models are to be replaced by Series 3 Models 1203 and 1503 respectively.

**MANUFACTURERS AND DISTRIBUTORS:**

1) Amazonen-Werke
H. Dreyer GmbH & Co. KG.,
D-4507,
Hasbergen, Gaste,
West Germany.

Distributor: Mohawk Equipment Ltd.,
Ewart Ave.,
P.O. Box 103,
Brantford, Ontario
N3T 5M3.

Telephone: (519) 753-3164
Fax: (519) 753-3166

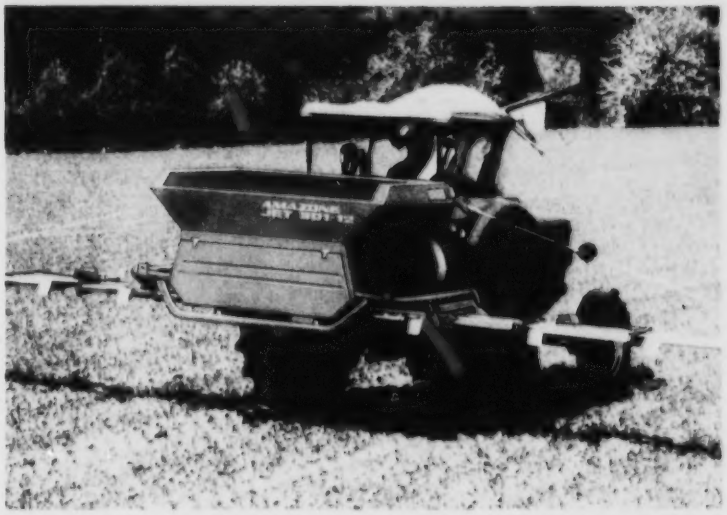
**CURRENT USERS AND NUMBER OF UNITS:**

| | | |
|---|---|---|
| Chapleau | — | |
| Dryden | — | |
| Gogama | 1 | 802 |
| Kemptville | 1 | 801 |
| Midhurst | 1 | 801 |
| Orono | — | |
| St. Williams | — | |
| Swastika | 1 | 1201 |
| Thessalon | — | |
| Thunder Bay | 1 | 1502 |

**PRICE OF CURRENT MODELS:**

| | | |
|---|---|---|
| Amazone Jet w/ 12 m boom | Model 1203 | $9,400.00 |
| | Model 1503 | $9,950.00 |

Note: Pricing fluctuates with the exchange rates between Canadian and West German currency. Contact the Canadian distributor for current pricing.



Pneumatic Spreader.

## TECHNICAL INFORMATION

### SPECIFICATIONS:

| Model | 802 | 1203 | 1503 |
|---|---|---|---|
| Hopper Capacity | 800 L | 1200 L | 1500 L |
| Working Width | 10 - 15 m | 10 - 18 m | 10 - 18 m |
| Transport Width | 2.5 - 2.9 m | 2.5 - 2.9 m | 2.5 - 2.9 m |
| Filling Height | 0.9 - 1.05 m | 0.9 - 1.05 m | 0.9 - 1.05 m |
| Boom Lift | Manual (standard) on 10 and 12 m booms. Hydraulic (standard) on booms greater than 15 m. | | |
| Jets | 16 jets on 10 and 12 m booms. 32 jets on 15 to 18 m booms. | | |
| Net Weight | 410 - 480 kg | 496 - 642 kg | 526 - 672 kg |
| Spread Rates | 30 - 830 kg/ha | 30 - 830 kg/ha | 30 - 830 kg/ha |
| | The actual spread rates are dependent upon the type of material being spread. | | |

### OPTIONAL EQUIPMENT:

1) Models 1203H and 1503H utilize a computer-controlled feed mechanism and variable speed hydraulic drive. The computer maintains an accurate, present spread rate regardless of the ground speed of the tractor.

2) Models with 10 and 12 booms can be fitted with hydraulic boom lifters.

3) Replacement metering mechanisms are available for producing the lower application rates required by micro-granular materials such as some powdered chemicals or fine seeds for seeding fallowed fields.

## PRIME MOVER

### TYPE:

Standard agricultural tractor equipped with hydraulics.

### NET POWER REQUIREMENT:

| | |
|---|---|
| Model 802 | Minimum of 37 kw. |
| Model 1203 | Minimum of 44 kw. |
| Model 1503 | Minimum of 58 kw. |

### ATTACHMENT:

Three-point hitch.

## TASK PERFORMED

Pneumatic spreaders are used to spread powdered and granulated fertilizers onto nursery beds.

## HOW IT WORKS

### WORKING PRINCIPLE:

Pneumatic fertilizer spreaders use air flow to assist in transporting fertilizer to outlets located regularly across a folding boom.

### GENERAL DESCRIPTION:

Fertilizer is carried within a large bulk hopper. The material is gravity-fed through hydraulically adjustable shutter openings at the base of the hopper. Then fertilizer passes through a stud-wheel metering mechanism and into an injector jet unit, which directs the flow to the individual boom outlets.

The feeder mechanism may be easily removed by hand for cleaning or replacement. Optional feeder wheels are available to facilitate extreme low or high application rates to suit the materials being spread.

A fan unit, beneath the hopper, creates air flow that propels the fertilizer from the injector jets, down a series of PVC distribution pipes to the spreader outlets located along booms on either side of the spreader.

Each outlet consists of a curved director chute and a deflector plate, which determine the direction and the spread pattern of the fertilizer flowing from each outlet. Fertilizer is distributed in a manner similar to the way liquid chemicals are sprayed from a boom sprayer.

To adjust for the proper spreading rate the injector jet units are removed and calibration buckets are installed beneath the feeder wheels. The spread rate is changed by loosening a single nut and turning an eccentric disc incorporated into the drive mechanism.

The spreader mounts to a standard three-point hitch and uses the hydraulic lifting capabilities to raise or lower the unit for loading fertilizer and dismounting.

The tractor PTO drives the blower unit and the feeder mechanism through a series of chains and belts easily accessible via a removable panel on the rear of the spreader. Tractor hydraulics are utilized for operation of the shutter control in the bottom of the hopper and also in some cases for folding and unfolding the booms.

### LIMITING FACTORS:

1) The standard metering mechanism will meter material at 30 to 830 kg/ha. For materials requiring rates above or below this range, special metering mechanisms must be ordered.

## OPERATIONAL INFORMATION

### STAFF REQUIREMENTS:

One person is required to drive the tractor, adjust and calibrate the feeding units, and operate the spreader controls.

### SAFETY ASPECTS:

1) Personnel must be well clear of the immediate area before the booms are hydraulically lowered.

2) Operators must be aware of the manufacturer's recommended handling and usage precautions associated with the dry chemicals.

3) Normal safety practices for agricultural machinery should be observed particularly those that apply to:

i) working with and maintaining hydraulics;

ii) mounting and dismounting heavy equipment.

**MAINTENANCE:**

**Daily** - Clean to remove all fertilizer residues that could corrode or plug up the unit.

- Inspect and lubricate the drive mechanism.

**Special maintenance equipment required** - None.

**Major repair items** - None.

**Ease of repair** - Very good. Many parts that are frequently exchanged or removed during operation are modular. The simple removal of a pin or thumb-screw will allow many parts to be removed or exchanged.

**Parts availability** - Good.

**USERS' ASSESSMENT**

**ADVANTAGES:**

1) A pneumatic spreader with a 10-12 m boom can evenly and precisely distribute fertilizer over three nursery-beds in one pass. A simple rotary spreader covers three beds plus some overlap. A pendulum spreader covers three beds with little to no overlap, but lacks the precision of the pneumatic spreader.

2) The distribution pattern of the pneumatic spreader is not affected by granule size or humidity as are rotary and pendulum-type spreaders.

3) The pneumatic spreader is more flexible than the other types of spreaders. Simple adjustments give the operator much greater control over the rate of spread and the distribution pattern, regardless of the fertilizer characteristics.

**DISADVANTAGES:**

1) The pneumatic spreader, in general, requires a larger tractor than a rotary or pendulum-type spreader. In addition the pneumatic spreader requires a tractor with hydraulics.

2) The pneumatic spreader is a much more complex piece of machinery than either the rotary or pendulum-type spreader. Maintenance and inspection procedures are more involved.

3) The mounting procedures for the pneumatic spreader are more complex than rotary and pendulum spreaders. Since spreading operations are frequent during the growing season, it is advantageous to dedicate a tractor to the unit for the entire season.

4) Despite claims that air-assisted spreaders blow the fertilizer to the ground and off the foliage, in practice, fields must still be washed down to prevent fertilizer from burning the foliage.

**OPERATIONAL GROUP:**

**5** Fertilization and Soil Amendments

**EQUIPMENT TYPE:**

**5.02** Rotary Spreaders

**MAKES AND MODELS IN USE:**

1) Bogballe, Model B-700
2) Eurospand, Model S-501-L
   S-300-L
3) New Idea, Model 109
4) Teagle, Model 1200 series E

**MANUFACTURERS AND DISTRIBUTORS:**

1) Bogballe, A.P Laursen A/S,
   7171 Uldum, Denmark,
   7059191

   Telephone: 45-5-893266
   Telex: 61132 apl dk

   Distributors: Maritime Farm Supplies Limited,
   P.O. Box 1398,
   Moncton, New Brunswick
   E1C 8T6

   Telephone: (506)382-4442
   Telex: 014-2601

2) O.M.A.B., (Eurospand),
   Regione S.Anna 98,
   Boves 12012,
   Cuneo, Italy

   Telephone: 01-71-880655
   Telex: 210314

3) Teagle Machinery Limited,
   Blackwater,
   Truro, Cornwall
   England
   TR4 8NQ

   Telephone: 872-560592
   Telex: 455-573

   Distributors: Trudel Farm Equipment,
   New Liskeard, Ontario
   P0J 1P0

   Telephone: (705) 647-6065

Note: The New Idea Fertilizer Spreader line has been discontinued.

New Idea Model 109 in use at the St. Williams Nursery.

**CURRENT USERS AND NUMBER OF UNITS:**

| | | |
|---|---|---|
| Chapleau | — | |
| Dryden | 2 | Bogballe |
| Gogama | 1 | Forano |
| Kemptville | 1 | Bogballe |
| Midhurst | — | |
| Orono | 1 | New Idea |
| | 1 | Bogballe |
| St. Williams | 1 | New Idea |
| Swastika | 1 | Eurospand |
| Thessalon | — | |
| Thunder Bay | 1 | Bogballe |

## TECHNICAL INFORMATION

**SPECIFICATIONS:**

The following information lists the general range of specifications available for this type of equipment. A detailed listing for the Bogballe B-700 is also included because it is currently the most common model and size of spreader in provincial tree nurseries.

| Make | **General** | **Bogballe B-700** |
|---|---|---|
| Net Weight | 71 - 201 kg | 136 kg |
| Width | 135 - 186 cm | 135 cm |
| Length | 119 - 167 cm | 119 cm |
| Height | 96 - 135 cm | 135 cm |
| Hopper Opening | | |
| Length | 115 - 131 cm | 115 cm |
| Width | 81 - 179 cm | 81 cm |
| Capacity | 230 - 1000 kg | 700 kg |
| Spread Capacity | 30 - 1500 kg/ha | 30 - 1500 kg/ha |
| Spread Width (Granular) | 8 - 12 m | 12 m |
| Spread Width (Powdered) | 4 - 7 m | 5 - 7 m |
| Revolutions | 540 rpm | 540 rpm |

**OPTIONAL EQUIPMENT:**

Typical optional equipment includes:

1) Hopper side extensions to increase the capacity.

2) Agitator assemblies which mount into the base of the hopper to help keep powdered fertilizers flowing smoothly towards the base of the hopper.

**SPECIAL MODIFICATIONS:**

1) Two additional vertical spreader fins were added to each of the distribution discs on the New Idea Model 109 at St. Williams Nursery to even out surges in the flow of materials.

Close up of one of the dual distribution discs on the New Idea spreader at St. Williams showing the additional spreader fins.

## PRIME MOVER

### TYPE:

Standard agricultural tractor.

### NET POWER REQUIREMENT:

Minimum of 22 kw.

### ATTACHMENT:

Three-point hitch.
Tractor PTO shaft.

## TASK PERFORMED

Rotary spreaders are used to spread powdered and granular fertilizers. The unit may also be utilized to sow oats and rye in fallowed nursery compartments.

## HOW IT WORKS

### GENERAL DESCRIPTION AND WORKING PRINCIPLE:

Dry pelletized fertilizer or, in some cases, seeds are carried within a hopper mounted to the three-point hitch of an agricultural tractor. Materials in the hopper are gravity-fed through an adjustable opening at the base of the hopper.

Material exiting the hopper falls into a distribution system normally consisting of one or more rotating discs with vertically oriented fins. Material falling onto the discs is distributed by centrifugal force out from the rear of the unit in a fan-shaped pattern. The spread width of the pattern is usually adjustable.

The distribution mechanism is in most cases very simple in design. It consists of a shaft that connects the tractor PTO to a transmission at the base of the hopper. The transmission transfers rotation to the distribution discs. The discs are flat to slightly concave with two or more fins on the upper surface to catch and direct the materials outwards.

Some makes, such as Bogballe, incorporate a specially designed distribution system that operates on similar principles but provides additional or alternate means of controlling spreader distribution patterns.

Typically, the spreader is driven up and down the length of each compartment in a pattern of overlapping swaths. Successive swaths are covered so that the spread pattern eventually stretches across the entire width of the nursery compartment or field with an even distribution of material.

The spread pattern for each individual pass produces an even distribution pattern across the central portion of each swath with noticeable decrease in materials distributed into the outer 1 to 2 m along the edges. Adjacent swaths are overlapped to even out the spread pattern across the entire compartment.

### LIMITING FACTORS:

1) Fine granules and powdered materials do not spread well. The finer particles are not distributed as consistently or as far as regular granulated fertilizer. In general, finer materials require more passes to cover a given area.

2) As humidity levels increase, fertilizers become sticky. This alters the normal expected distribution pattern for the fertilizer.

## OPERATIONAL INFORMATION

### STAFF REQUIREMENTS:

One person is required to operate the tractor and reload the hopper as required.

### SAFETY ASPECTS:

All personnel should remain clear of the rear of the unit when it is in operation.

Operators should be familiar with the manufacturer's recommended precautions and handling procedures associated with the fertilizers being spread.

Standard safety procedures applicable to agricultural machinery should be observed, e.g., proper mounting and dismounting procedures.

### MAINTENANCE:

**Daily** - clean off all fertilizer residues and grease unit.

**Special maintenance equipment required** - None.

**Major repair items** - None.

**Ease of repair** - Very good. The design and function is straightforward. Parts are accessible.

**Parts availability** - This equipment is widely used in agriculture so that local farm equipment dealers can supply most parts readily.

### PRODUCTION RATES:

A single pass will cover a swath 9 to 10 m wide. The unit generally progresses at 4.8 to 6.4 km per hour.

The actual rate of application varies with the type of fertilizer and the application requirements as determined by the nursery manager.

## USERS' ASSESSMENT

### ADVANTAGES:

1) Simple and reliable design.

2) Good for general purpose applications.

3) Simple set-up and operation. Unit can be quickly mounted and put in use for small fertilization jobs. By comparison, pneumatic spreaders are large, heavy, and require approximately one-and-a-half hours for mounting and set-up. In practice, once a pneumatic spreader is mounted on a tractor it essentially ties up that tractor for the operating season. The simple rotary spreader does not.

### DISADVANTAGES:

1) Some nurseries report that even with precautions taken, there are inconsistencies in the distribution of fertilizer.

2) Since the fertilizer is simply cast out onto the nursery-beds, fertilizer granules tend to settle amongst the seedling foliage. To prevent burning, field irrigation must be used to wash the fertilizer off the foliage.

**OPERATIONAL GROUP:**

**5** Fertilization and Soil Amendments

**EQUIPMENT TYPE:**

**5.03** Pendulum Spreaders

**MAKES AND MODELS IN USE:**

1) Vicon, PS302
PS400
PS602

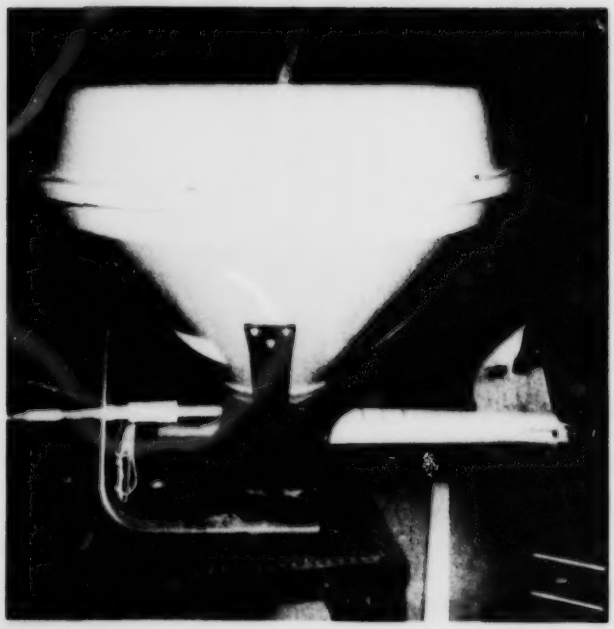
Note: The PS302, PS400 and the PS602 have since been superseded by the models PS303, PS403 and PS603 respectively.

**MANUFACTURERS AND DISTRIBUTORS:**

1) Vicon Eastern Canada,
P.O. Box 10,
Cambridge, Ontario
N1R 5T1

Telephone: (519) 740-2800

Distributors: Farm equipment dealerships located in most farming districts of Ontario.



Pendulum Spreader.

**CURRENT USERS AND NUMBER OF UNITS:**

| | |
|---|---|
| Chapleau | 1 |
| Dryden | — |
| Gogama | 1 |
| Kemptville | — |
| Midhurst | 1 |
| Orono | 1 |
| St. Williams | — |
| Swastika | 1 |
| Thessalon | — |
| Thunder Bay | — |

**PRICE OF CURRENT MODELS:**

| | |
|---|---|
| PS303 | $1,284.00 |
| PS403 | $1,894.00 |
| PS603 | $2,218.00 |

Prices for other models range from $1,206.00 for the PS23, the smallest mounted model, to $5,568.00 for the PS1503T, the largest trailing model.

## TECHNICAL INFORMATION

### SPECIFICATIONS:

| Model | PS303 | PS403 | PS603 |
|---|---|---|---|
| Hopper Capacity: | 272 kg | 431 kg | 635 kg |
| (cubic meters) | 0.03 $m^3$ | 0.40 $m^3$ | 0.60 $m^3$ |
| Filling Height | 0.91 m | 0.89 m | 0.94 m |
| Overlapped Spread Width | 6.1 — 14.0 m | | |
| Weight | 80 kg | 121 kg | 145 kg |
| Hitch-type | Cat. I & II Three-point | | |
| Construction | Stainless steel, polyester, nylon | | |

### OPTIONAL EQUIPMENT:

1) Wind shields for spreading powders.

2) Fine seed kit.

3) Variety of spouts, e.g., stainless steel, narrow spread width, and others for special distribution patterns.

4) Hopper covers.

5) Manual and hydraulic shut-offs.

## PRIME MOVER

### TYPE:

Standard agricultural tractor.

### NET POWER REQUIREMENT:

Minimum of 22 kw.

### ATTACHMENT:

Three-point hitch.

Note: The large, wheeled, trailing models utilize a standard draw-bar hitch.

## TASK PERFORMED

Pendulum spreaders are used to spread powdered and granular fertilizers in nursery compartments.

## HOW IT WORKS

### GENERAL DESCRIPTION AND WORKING PRINCIPLE:

Fertilizer is carried within a bulk hopper mounted to the tractor's three-point hitch. The material is gravity-fed to a distribution mechanism at the base of the hopper.

The distribution mechanism consists of a movable dish with a detachable spout extending to the rear of the spreader. A shaft from the tractor PTO connects with a flywheel with an integral slip clutch on the rear of the unit. The rotation of the flywheel is converted into an oscillating side-to-side action of the distribution spout by a yoke and offset axle.

A variable aperture in the base of the hopper controls the flow of materials from the hopper into the distributor dish. Materials in the dish are thrown by centrifugal force down the specially profiled spout, where they are deflected by small plates or metallic bands to produce the characteristic distribution pattern.

The distribution pattern for a standard pendulum-type spreader is basically symmetrical about the spreader, with the bulk of the distributed materials falling within a 4 to 5 m swath around the spreader. The pattern gradually tapers off to an overall spread width of 14 m.

To maintain an even distribution of materials across a field or compartment, adjacent passes of the spreader are overlapped. The combined deposition of materials in the overlapping areas evens out the distribution and prevents banding of the field.

### LIMITING FACTORS:

1) Fine powdered materials are not distributed well by the spreader in its standard configuration. The very small particle size of powdered materials results in reduced spreading widths because individual particles do not possess enough momentum to carry them to the usual full spreading widths of granulated materials. Wind currents distort the distribution. It is recommended that the optional windscreen be used for fine, powdered fertilizers.

2) Atmospheric humidity makes fertilizers sticky. Particles will tend to clump together more noticeably as humidity increases, thereby changing the distribution pattern.

## OPERATIONAL INFORMATION

### STAFF REQUIREMENTS:

One person is required to operate the tractor and reload the hopper as required.

### SAFETY ASPECTS:

1) All personnel should remain clear of the rear of the unit while it is in operation.

2) The operators should be thoroughly briefed on the safe handling and usage recommendations by the manufacturer of the chemicals being spread.

3) Standard safety procedures for agricultural machinery should be observed.

**MAINTENANCE:**

Thoroughly wash and clean the unit after each use.

**Special maintenance equipment required** - None.

**Major repair items** - None required.

**Ease of repair** - Very good. Parts are easily accessible.

**Parts availability** - Very good.

**PRODUCTION RATES:**

The actual rate of application will depend upon the type of fertilizer being spread and upon the application requirements.

The models currently available have a typical spreading width of from 6 to 14 m and travel at approximately 5 to 7 km/hr during operation.

**USERS' ASSESSMENT**

**ADVANTAGES:**

1) Simple design that is easy to maintain.

2) Good for general purpose spreading.

3) In practice it has been found that the pendulum-type spreader exhibits a more even distribution than the rotary spreaders.

4) Very easy to set up and operate in comparison to the larger and more complex pneumatic-type spreaders.

**DISADVANTAGES:**

1) Since the fertilizer is simply tossed out over the field, granules frequently lodge amongst the foliage. In order to prevent burning of the seedlings, nursery compartments must be thoroughly watered following fertilizing.

2) The distribution of fertilizers is affected by the humidity of the air and the strength and direction of winds.

**OPERATIONAL GROUP:**

**5** Fertilization and Soil Amendments

**EQUIPMENT TYPE:**

**5.04** Fertilizer Injectors

**MAKES AND MODELS IN USE:**

1) Dragon Engineering Company, Models 40 & 80

2) Smith Measure Mix, Model R-8

**MANUFACTURERS AND DISTRIBUTORS:**

1) Anderson Pump Company,
Dragon Engineering Division,
P.O. Box 906,
Chowchilla, California
U.S.A. 93610

Telephone: (209) 665-4477

Distributor: Vanden-Bussche Irrigation,
No. 3 Highway South,
Delhi, Ontario
N4B 2X1

Telephone: (519) 582-2380
Telex: 061-81190

2) Smith Precision,
Newbury Park, California,
U.S.A.

Distributor: Plant Products Co. Ltd.,
314 Orenda Blvd.,
Bramalea, Ontario
L6T 1G1

Telephone: (416) 793-7000
Telex: 06-97595

**PRICE OF CURRENT MODELS:**

| Injector Tanks: | | Galvanized | Petroleum Coating |
|---|---|---|---|
| Models: | 40 | $ 775.00 | $ 721.00 |
| | 80 | $ 1063.00 | $ 980.00 |
| 2.7 cm Filler Funnel | | $ 33.00 | |

Venturis:

Price Range from $110.00 to $451.00

Price of Venturis is dependent upon

1) Pipe diameter.

2) Material: aluminum, steel.

3) Threaded or non-threaded.

All (Dragon Engineering) prices are FOB Chowchilla and quoted in $US.

Dragon Engineering Model 80 fertilizer injector at St. Williams Nursery.

| | | |
|---|---|---|
| Smith Measure-Mix | | Model R-8 |
| | | Price $3,575.00 |
| Fertilizer Drums | 95 L | $ 46.50 |
| | 170 L | $110.00 |

All Smith prices are FOB Brampton, Ontario.

**CURRENT USERS AND NUMBER OF UNITS:**

| | |
|---|---|
| Chapleau | — |
| Dryden | 2 |
| Gogama | — |
| Kemptville | 1 |
| Midhurst | 1 ** |
| Orono | — |
| St. Williams | 2 |
| Swastika | 2 |
| Thessalon | — |
| Thunder Bay | 1 |

** Smith, Measure-Mix R-8

Note: Unless otherwise noted, all units are manufactured by Anderson Pump Company.

## TECHNICAL INFORMATION

**SPECIFICATIONS:**

| Specification: | | **Dragon 40** | **Dragon 80** | **Smith R-8** |
|---|---|---|---|---|
| Weight Empty | | 73 kg | 104 kg | 113 kg |
| Fertilizer Capacity | Dry | 91 kg | 181 kg | |
| | Liquid | 151 L | 303 L | 95/170 L |
| Height | | 131 cm | 155 cm | 48 cm |
| Tank Diameter | | 51 cm | 61 cm | 28 x 56 cm ** |
| Inlet/Outlet Diam. | | 5 - 25 cm | | 5 cm |
| Flow Rate | | 185 - 4633 L/min. | | 76 - 379 L/min. |

** Note: The Smith R-8 measurements are the length and width dimensions of the unit as a whole. The Smith unit operates on a similar principle to the Dragon units but is set up in a different configuration that eliminates the large cylindrical tank.

## TASK PERFORMED

The fertilizer injector is used to distribute dry soluble fertilizers or liquid fertilizers.

The primary use for this equipment is in the fertilization of rising 1+0 shaded fields.

## HOW IT WORKS

### WORKING PRINCIPLE:

A Venturi section is placed in line with the nursery irrigation system. Water pressure builds up on the pump side of the Venturi, forcing water from the irrigation system through a pressure hose to the base of the injector tank.

The water entering into the base of the injector tank is forced up through fertilizer that has previously been loaded into the tank. This action causes a thorough mixing which dissolves dry fertilizers.

Once the tank becomes pressurized, the fertilizer solution is forced out through the injector hose into the irrigation line under both the pressure from the tank and suction produced by the Venturi.

The fertilizer solution is injected back into the irrigation system, where it is distributed to all of the branch lines and sprinkler heads by the system flow.

### GENERAL DESCRIPTION:

A typical fertilizer injector consists of a steel mixing tank and a Venturi unit.

The tank is supported on its end by a steel supporting frame. A covered opening on its upper end is used to recharge the tank with soluble fertilizers. The bottom end of the tank is funnel-shaped and terminates in an elbow pipe connection to a flexible hose.

The Venturi section is placed in line with the irrigation system. On the pump side of the Venturi, a globe valve connects to the hose leading to the base of the tank. This hose is termed the pressure hose.

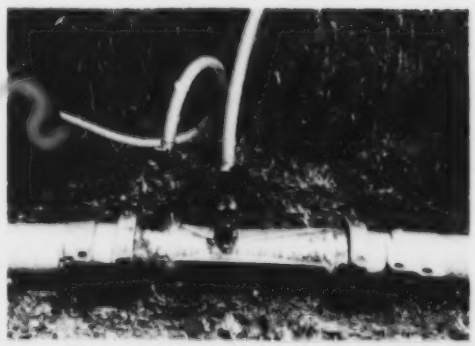
A second hose is connected to a fitting near the recharge opening at the top of the tank or on the side of the tank on some versions. This injector hose leads to a valve at the throat of the Venturi.

The Venturi is a short section of tubing with constricted side walls in its central portion that cause water pressure to build up on the pump side of the Venturi. At the same time the velocity of the water flowing through the short, narrow Venturi section increases significantly. The speed of the water flow can be controlled by a valve which increases or decreases the diameter of the constriction.

The injector hose connects to an opening at the narrowest part of the constriction. The rapid flow of water over the out-flow opening creates suction in the injector hose, which draws the fertilizer solution into the irrigation system.

### LIMITING FACTORS:

All fertilizers must be completely soluble and capable of rapidly breaking down in water in order to prevent clogging of the injector hoses or the sprinkler heads.



Close up of the Venturi section inserted into the irrigation line.

## OPERATIONAL INFORMATION

### STAFF REQUIREMENTS:

One person is required to load and adjust the injector as required.

### SAFETY ASPECTS:

Operators should be aware of and follow fertilizer manufacturer's handling instructions.

### MAINTENANCE:

The injector is a very simple device that requires little maintenance on a daily or weekly basis.

Seasonally, the tank should be cleaned and painted with a rust-inhibiting paint to prevent deterioration of the steel tank, particularly during extended periods of off-season storage.

### PRODUCTION RATES:

A single charge of fertilizer in the Dragon Model 80 can be applied in 20 to 30 minutes. The actual speed of application will be governed by adjustments made to the Venturi. The application rate will be determined by the area covered by the sprinkler set-up and the amount of fertilizer loaded into the injector tank.

## USERS' ASSESSMENT

### ADVANTAGES:

1) Makes use of existing irrigation system. Eliminates the need for separate fertilizer application operations.

2) Very low operating and maintenance costs.

3) The fertilizer applied in solution reaches the soil surface through slatted nursery-bed shades more evenly than does fertilizer applied in dry pelletized form.

In dry form, fertilizer tends to deflect off the shades into the pathways between the beds. The slat arrangement of the shades interferes with the distribution of the fertilizer pellets that pass through the shades.

### DISADVANTAGES:

1) A fertilizer spreader operator can control the application more directly than with the irrigation system, and can minimize over-spread out of the growing compartment and ensure an even spread over the compartment.

Overlap of the spray from adjacent sprinkler heads may cause some portions of the compartment to receive more fertilizer while other areas on the fringe of a single spray head may get less than desired.

In order to have the irrigation system cover the entire field, some of the spray arcs may extend beyond the boundaries of the compartment, wasting fertilizer and upsetting the calculated application rate.

**OPERATIONAL GROUP:**

**5** Fertilization and Soil Amendments

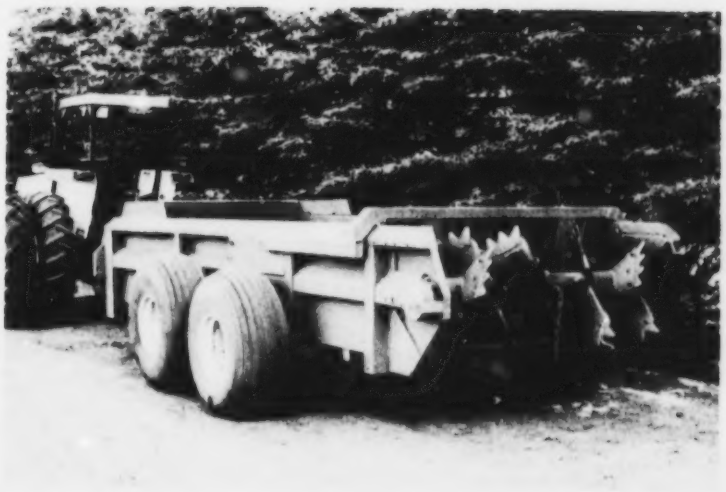
**EQUIPMENT TYPE:**

**5.05** Manure Spreaders

**MAKES AND MODELS IN USE:**

| | | |
|---|---|---|
| 1) International Harvester, | Models | 330 |
| | | 530 |
| | | 550 |
| | | 570 |
| | | 575 |
| 2) John Deere, | Models | 34 * |
| | | 40* |
| | | 660 |
| | | 780 Hydra-Push |
| 3) New Holland, | Model | 645 |
| 4) Massey Ferguson, | Model | 160 |

* Not available.



John Deere 780 hydra-push spreader, Thunder Bay Nursery.

**MANUFACTURERS AND DISTRIBUTORS:**

1) International Harvester is now owned and operated by the agricultural machine division of J. I. Case Ltd.

J. I. Case Canada Limited,
3350 South Service Road,
Burlington, Ontario
L7N 3M6

Telephone: (416) 632-3800

Distributors: Dealerships located across Ontario.

2) John Deere Ltd.,
P. O. Box 1000,
Grimsby, Ontario
L3M 4H5

Telephone: (416) 945-9281

Distributors: Dealerships located throughout Ontario.

3) Ford - New Holland of Canada Limited,
P.O. Box 7000,
Brampton, Ontario
L6V 2M9
Distributors: New Holland, Ford-New Holland, and Ford dealerships located throughout Ontario.

4) Massey Ferguson Industries Limited,
9th Floor,
595 Bay Street,
Toronto, Ontario
M5G 2C3

Telephone: (416) 593-3811 [Varity Corporation]

Distributors: Dealerships located throughout Ontario.

**CURRENT USERS AND NUMBER OF UNITS:**

| | | |
|---|---|---|
| Chapleau | 1 | John Deere |
| Dryden | 1 | New Holland |
| Gogama | 1 | Massey Ferguson |
| | 1 | International |
| Kemptville | 1 | John Deere |
| Midhurst | 2 | International |
| Orono | 1 | International |
| St. Williams | 3 | International |
| Swastika | 2 | International |
| | 2 | John Deere |
| Thessalon | 1 | International |
| Thunder Bay | 2 | International |
| | 1 | John Deere |

**TECHNICAL INFORMATION**

**SPECIFICATIONS:**

| 1) Make | **Case I.H.** | **John Deere** |
|---|---|---|
| Models Available | 6 models | N/A |
| No. Axles | Single or Tandem | Single or Tandem |
| Capacity - Heaped | 4.2 - 9.8 $m^3$ | 8.1 - 12.0 $m^3$ |
| - Struck | 2.3 - 6.6 $m^3$ | 4.0 - 6.3 $m^3$ |
| Box Dimensions | | |
| - Length | 325 - 515 cm | N/A |
| - Width | 122 - 183 cm | 157 - 181 cm |
| - Depth | 57 - 72 cm | 70 - 77 cm |
| Max. Load Height | 18 - 136 cm | 120 - 131 cm |
| Construction | | |
| - Sides | Corrosion-resistant steel | Fibre-glass reinforced plastic on a plywood core |
| - Deck | 19 mm treated plywood | " " |
| - Frame | Heavy tube steel box frame | A-Frame to rear axle |
| Feed Mechanism | Two speed worm gear drive | Continuously variable speed |
| | Single, or on some models, dual T-bar chain drive | Hydraulic sliding floor and panel |
| | 14 - 32 bars | 0 - 4.9 m per minute |
| | 42 bars with dual chains | |
| Beaters | Steel deep-crimp bear claw design | Serrated paddle design |
| | 318/348 rpm | 226 rpm |
| | 12 - 20 paddles | |
| Unit Weight | 43 - 1949 kg | 1220 - 2315 kg |

**NET POWER REQUIREMENT:**

22 to 75 kw.

**ATTACHMENT:**

Standard draw-bar hitch and tractor PTO.

## TASK PERFORMED

Manure spreaders are used for spreading peat and sawdust as organic matter or seedbed mulch.

Large spreaders are used for spreading organic materials on nursery compartments for incorporation into the soil prior to planting. Smaller, narrower versions with suitable wheel base dimensions can also be used to spread organic mulch on seedbeds.

## HOW IT WORKS

**GENERAL DESCRIPTION AND WORKING PRINCIPLE:**

A basic manure spreader consists of a containment box, a beater mechanism to spread the material, and a feed mechanism to move the materials towards the beater.

The box is generally of shallow construction with side and bottom panels fabricated from heavy, treated plywood or plywood encased in plastic and/or fibreglass. Some makes incorporate panels of corrosion-resistant steel.

Normally the box serves as the main frame for the spreader by incorporating a steel frame around the base and outer edges for strength. Alternatively, some models possess a steel subframe below the box for additional support. In either case the unit attaches through a simple draw-bar hitch to the tractor.

Pneumatic farm implement-type wheels, in either dual or single axle configurations, are used to support the weight of the spreader and its load. A variety of different tire widths and sizes allow the unit to be tailored to field conditions.

The beater mechanism is located at the rear of the box. A series of angled paddles are welded or bolted to an axle across the width of the rear of the box. Each paddle is fabricated of heavy steel that may be ribbed for strength, and is serrated along the outer edge. An optional secondary beater mechanism may be mounted above and slightly in front of the main beaters to assist in spreading heaped loads and to spread out the load for a more even feed to the main beaters.

As the paddles rotate, they gouge into the material in the box. The speed of the paddles and the serrated edges pulverize any lumps. The material picked up by the paddles is thrown up and out from the rear of the spreader and settles in a relatively uniform mat on the surface of the ground behind the advancing spreader.

Some nurseries have replaced the axle and large beater paddles with a roller and auger to decrease the flow rate and allow better control over the distribution of peat onto the nursery beds. (Kemptville Nursery)

A feed mechanism is incorporated into the floor of all spreaders to keep the material moving towards the beater. Normally the feeding action is accomplished by a continuous chain drive with feeder bars that stretch across the width of the containment box. The chain drive pulls the

feeder bars along the floor of the box from the front to rear.

A different concept used on some John Deere models is to have a hydraulically operated platform and panel advance from the front to the rear of the box, pushing the load into the beater at a rate controlled by a hydrauiic setting on the tractor.

Most makes and models come equipped with or have the option of including a hydraulic gate immediately in front of the beaters to contain materials within the box during transport.

All of the makes currently utilize a mechanical connection to the PTO to drive the beater mechanism. Most makes also use the mechanical PTO connections to power the feed system. Massey Ferguson drives its feed system with a hydraulic motor. John Deere Hydra-push models use large hydraulic cylinders to operate the sliding platform and panel.

**LIMITING FACTORS:**

1) Large spreaders such as the John Deere 780 Hydra-push are limited by their large axle widths, which are too wide to pass down seedbeds without having the wheels interfere with adjacent beds. The larger models cannot be used for top mulching.

**OPERATIONAL INFORMATION**

**STAFF REQUIREMENTS:**

**Operator** - One person is required to drive the tractor.

**Support** - One person may be required to reload the spreader.

**SAFETY ASPECTS:**

1) Personnel should remain clear of the rear of the spreader during operation. Stray sticks, stones, or compacted chunks thrown by the beaters could cause serious injury.

2) No one should work in or on any part of a spreader while the PTO or hydraulics are engaged.

**MAINTENANCE:**

- Grease and inspect parts regularly.

- Clean the box and beater paddles following each use.

**Special maintenance equipment required** - None.

**Major repair items** - Hydraulics.

**Ease of repair** - Good.

**Parts availability** - Very good.

**PRODUCTION RATES:**

John Deere 780 Hydra-Push can spread 250 cubic meters of peat in eight hours.

| 2) Make | **Massey Ferguson** | **New Holland** |
|---|---|---|
| Models Available | Four | Seven |
| No. Axles | Single/Tandem | Single/Tandem |
| Capacity - Heaped | 6.6 -10.9 $m^3$ | 3.9 - 12.5 $m^3$ |
| - Struck | 3.3 - 5.5 $m^3$ | N/A |
| Box Dimensions | | |
| - Length | N/A | |
| - Width | 142 - 165 cm | |
| - Depth | 74 cm | |
| Max. Load Height | 121 - 146 cm | |
| Construction | | |
| - Sides | Treated plywood | Corrosion resistant steel |
| - Deck | Fibre-glass treated plywood | Corrosion resistant steel |
| - Frame | A-Frame to rear axles on largest model<br>Trailing hitch beams to steel box frame on other models | A-Frame to rear axle |
| Feed Mechanism | 5-speed hydraulic gearbox<br>61 — 549 cm/min<br>T-Rod or pintle T-rod chain<br>14,515 and 13,608 kg tensile strength respectively | |
| Beaters | Replaceable comb type<br>12 - 14<br>77.5 cm diameter combs | Replaceable comb type<br>N/A |

**OPTIONAL EQUIPMENT:**

The following are typical of the options offered by most manufacturers.

1) Hydraulic end gate to contain the load during transport.
2) Top beater mechanism to help level out and spread heaped loads.
3) Litter/slurry pan to improve the distribution of materials.
4) Various types and widths of tires for different operating conditions.

**SPECIAL MODIFICATIONS:**

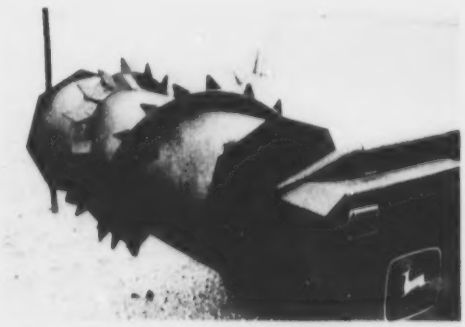
1) Beaters replaced by a roller and auger for spreading sawdust.

**PRIME MOVER**

**TYPE:**

Standard agricultural tractor.

Hydraulically operated units such as the John Deere 780 used at Thunder Bay require tractors with a large hydraulic fluid reservoir.



The modified beater mechanism at Dryden Nursery improves peat distribution.

## USERS' ASSESSMENT

### ADVANTAGES:

1) New large spreaders can spread peat more quickly than the small versions. The larger capacities and greater spread rates mean less time spent reloading the spreader and fewer trips around the field, thus less tire compaction within the fields.

2) Newer spreaders utilizing more hydraulic components have fewer moving parts to fail and cause down-time.

3) Hydraulic systems facilitate control of the spreader functions from the tractor. This eliminates the need for changing gears, chains, and pulleys on the spreader itself.

4) The use of hydraulics improves the operator's control over the speed of the various spreader functions. Mechanical systems are limited by transmissions, chains, gears and pulleys to a limited set of operating speeds. Hydraulics may be fine-tuned and set up for an almost infinite number of speeds.

### DISADVANTAGES:

1) Large spreaders have correspondingly large axle widths. As a result, large spreaders are not suitable for applying top mulch to nursery beds. Smaller versions can more easily be operated along nursery beds because the axle widths are often closer to the standard between-path distance.

2) Large spreaders require large horsepower tractors. Units such as the John Deere 780 Hydra-push require not only a large tractor but also a tractor with a large hydraulic fluid reservoir to satisfy the heavy hydraulics demand of the unit.

**OPERATIONAL GROUP:**

**6** Root Pruning

**EQUIPMENT TYPE:**

**6.01** Vertical Root Pruners

**MAKES AND MODELS IN USE:**

1) Fobro Vertical Root Pruner, Model 1000

**MANUFACTURERS AND DISTRIBUTORS:**

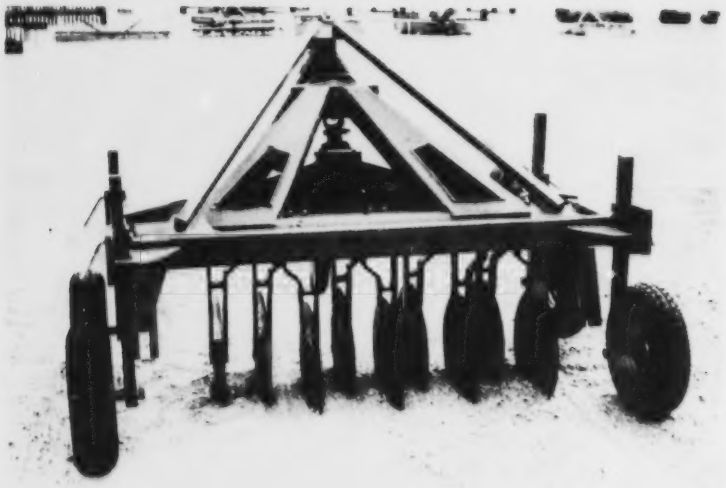
1) Baertschi & Co. Ltd.,
P. O. Box 1,
CH — 6152 Hueswil/Switzerland

Telephone: 045 88 16 16

Telex: 86 86 25 BCHU CH

Distributor: Canadian Forestry Equipment Ltd.,
7355 Torbram Road,
Unit 15,
Mississauga, Ontario
L4T 3W3

Telephone: (416) 678-1586



Fobro Model 1000 vertical root pruner, Dryden Nursery.

**CURRENT USERS AND NUMBER OF UNITS:**

| | | |
|---|---|---|
| Chapleau | — | |
| Dryden | 1 | Fobro |
| Gogama | — | |
| Kemptville | 1 | MNR |
| Midhurst | — | |
| Orono | — | |
| St. Williams | — | |
| Swastika | — | |
| Thessalon | — | |
| Thunder Bay | — | |

## TECHNICAL INFORMATION

### SPECIFICATIONS:

| Model | **1000** | **1500** |
|---|---|---|
| Working Depth | 25 cm | 25 cm |
| Working Width | 135 cm | 150 cm |
| Wheel Track (outside tires) | 186 cm | 201 cm |
| Weight | 585 kg | 615 kg |
| Total Length | 198 cm | 198 cm |
| Total Width | 160 cm | 175 cm |
| Total Height | 135 cm | 135 cm |

Note: The specifications listed above pertain to the basic Fobro wheeled frame. The unit has been designed to perform multiple functions through a series of optional attachments. For vertical root pruning, an attachment consisting of a tool-bar and a series of 9 adjustable coulter discs must be mounted to the unit.

### OPTIONAL EQUIPMENT:

1) Single-row lifting and shaking attachment.
2) Full-bed lifting and shaking attachment.
3) Horizontal reciprocating root pruner attachment.

## PRIME MOVER

### TYPE:

Standard agricultural tractor.

### NET POWER REQUIREMENT:

Minimum of 30 kw.

### ATTACHMENT:

Three-point hitch.

Power take-off.

## TASK PERFORMED

Vertical root pruners are used to control the lateral root growth between rows of seedlings in a nursery-bed.

## HOW IT WORKS

### WORKING PRINCIPLE:

As the unit progresses along the nursery-bed the vertically oriented blades slice into the soil on either side of each row of seedlings. The blades cut off all lateral roots extending beyond the preset blade spacing. The roots are cut cleanly by the sharpness of the blade in combination with the firm holding action of the moistened soil surrounding the roots.

**GENERAL DESCRIPTION:**

The Ministry-fabricated vertical root pruner in use at Kemptville Nursery consists of a simple rectangular steel frame and three-point hitch mount. Seven or nine vertical blades mount across the width of the frame to coincide with the spaces between rows in the nursery-beds.

Normally the blades are simple rolling coulters, although in some cases stationary vertical blades are used.

The commercially available Fobro unit operates on the same principles, but is more complex in design. The Fobro unit is a multi-function nursery implement that can, with appropriate optional equipment, be used for horizontal root pruning bed lifting and shaking, single-row lifting and shaking, as well as vertical root pruning.

The Fobro pruning unit consists of a heavy-duty wheeled frame with a three-point hitch mount. Two front- and two rear-mounted pneumatic wheels are fully height-adjustable or may be removed.

The Fobro incorporates a blade-shaking or oscillating feature produced by an enclosed transmission on the front of the frame that connects with a shaft from the tractor PTO.

A tool-bar and the coulter discs for vertical root-pruning attach to oscillating mounts on the underside of the frame. The individual coulters may be adjusted to any position along the tool-bar so that the blades cut equal distances from either side of each row of seedlings in the bed.

Straight stationary blades rely upon a sharp forward edge to cut through the roots. The roots must be firmly held in the soil or they will be pulled along through the soil, causing pulling and tearing damage.

The use of rolling coulters improves the cutting action by reducing root pulling. The rolling edge uses progressive vertical pressure to cut the roots rather than the horizontal pressure imparted by a stationary blade.

The oscillating action of the coulters on the Fobro unit impart an additional sawing action. The result is a quicker and cleaner cut with a minimum of root pulling.

**LIMITING FACTORS:**

1) The soil should be moist, at or near field capacity, to hold the roots firmly and ensure clean cutting.

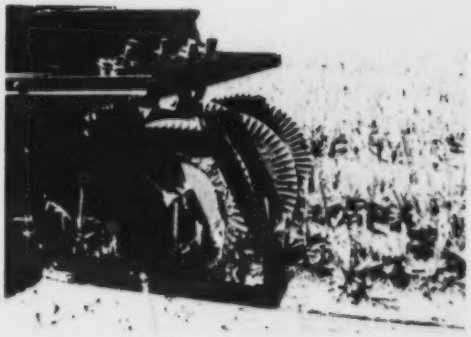
2) The key factor for successful root pruning, with minimal seedling damage, is operator skill. The operator must be able to maintain blade alignment at all times during operation. This same factor will also largely determine the overall speed of the operation.

3) Nursery-bed row spacing must be consistent.

**OPERATIONAL INFORMATION**

**STAFF REQUIREMENTS:**

One person is required to drive the tractor.



Nursery fabricated vertical root pruner at Kemptville Nursery.

**SAFETY ASPECTS:**

1) Two people should work together when mounting units like that in use at the Kemptville Nursery, which often do not have mounts or stands incorporated into their design and may tip.

2) All personnel should stand clear of the unit when it is being raised or lowered.

**MAINTENANCE:**

**Daily** - Grease all joints and bearings.

- The more complex commercial units should regularly undergo a thorough inspection.

**Seasonal** - Grease, clean and oil to prevent rusting.

**Special maintenance equipment required** - None.

**Major repair items** - Worn coulters blades.

**Ease of repair** - Good. All parts are readily accessible.

**Parts availability** - For homemade equipment, in most cases, readily available sources are used or can be adapted for use.

Fobro equipment is not widely used in Canada. Parts are available through the Canadian distributor, but delay is likely since parts must be ordered from Europe.

**PRODUCTION RATES:**

Approximately 27 m/minute.

**USERS' ASSESSMENT**

**ADVANTAGES:**

N/A

**DISADVANTAGES:**

1) For adequate pruning on older 3 + 0 stock, larger coulters are required to go deeper into the soil. Difficult to acquire coulters that can go sufficiently deep. (Kemptville)

2) The rows of seedlings in the beds must be kept very straight. Excessive seedling damage may result if the implement is used in uneven or crooked beds.

**OPERATIONAL GROUP:**

**6** Root Pruning

**EQUIPMENT TYPE:**

**6.02** Horizontal Root Pruners

**MAKES AND MODELS IN USE:**

1) Lotus Enterprises Ltd., Model MK-1

**MANUFACTURERS AND DISTRIBUTORS:**

1) Lotus Enterprises Ltd.,
13 Kaimahi Road,
Glenfield,
Auckland, New Zealand

Telephone: 64-9-444-7347

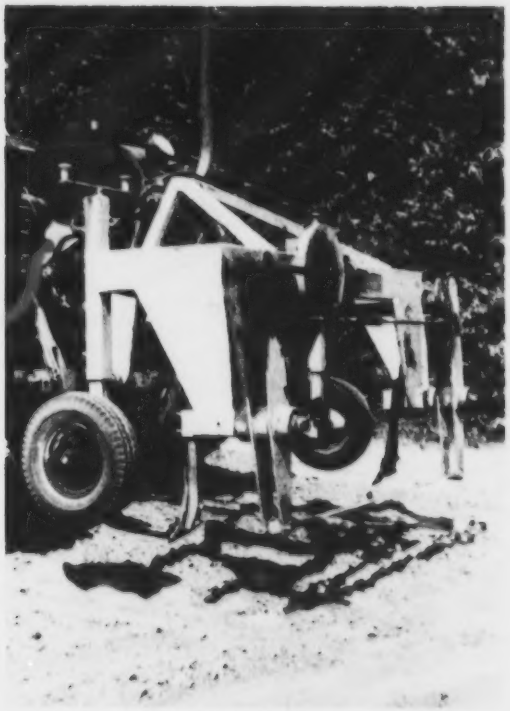
Distributors: None in North America

2) Grayco Potato Harvesters,
P. O. Box 86,
Heidelberg, Ontario

Telephone: (519) 699-5372

**CURRENT USERS AND NUMBER OF UNITS:**

| | | |
|---|---|---|
| Chapleau | — | |
| Dryden | 1 | |
| Gogama | 1 | Lotus |
| Kemptville | 1 | Grayco |
| Midhurst | 1 | MNR |
| Orono | 1 | Lotus |
| St. Williams | — | |
| Swastika | 1 | MNR |
| Thessalon | — | |
| Thunder Bay | 1 | MNR (fixed blade) |



Lotus reciprocating root pruner, Orono Nursery.

## TECHNICAL INFORMATION

### SPECIFICATIONS:

**Lotus Enterprises Reciprocating Pruner**

| | |
|---|---|
| Bed Width | - 121.9 cm |
| Path Width | - 45.7 — 61.0 cm |
| Max. Cutting Depth | - 25.4 cm |
| Min. Ground Clearance | - 45.7 cm |
| Frame Width | - 154.9 cm |
| Frame Length | - 71.1 cm |
| Depth Control Wheels | - Pneumatic Tires<br>182.9 cm between centres |
| Hitch | - Category II Three-point Hitch |
| Drive Shaft | - 3.8 cm diameter shaft |
| Eccentric Bearing | - Replaceable self-aligning cartridge unit |
| Power Arm and Tie Rod | - 3.8 cm steel rod with truck tie-rod ends |
| Reciprocating Arms | - 1020 HR steel flat |
| | - Bushings 5.1 cm O.D. 12.7 cm bronze with thrust washers |
| Frame Construction | - 10 x 10 cm square steel tubing |
| | - 0.48 cm wall thickness |
| | - Welded joints |

Note: In 1973 the U.S. Department of Agriculture evaluated the New Zealand Root Pruner, designed and built by Lotus Enterprises of New Zealand. Based upon the recommendations from the evaluation, the unit was redesigned. The preceding specifications were taken from a copy of the USDA's plans for the redesigned unit available at the Midhurst Tree Nursery.

### SPECIAL MODIFICATIONS:

1) Adjustable pneumatic tires were used to replace the depth control assemblies specified on the redesign plans. The original New Zealand pruner used skids in place of wheels.

2) The coulters and the mouldboard were omitted on the unit constructed by the Midhurst Tree Nursery.

### COMPLEMENTARY EQUIPMENT:

A path cultivator may be used to loosen the soil along the pathways to reduce the strain on the shaker arms during operation.

## PRIME MOVER

### TYPE:

Standard agricultural tractor.

**NET POWER REQUIREMENT:**

Minimum of 30 kw.

**ATTACHMENT:**

Three-point hitch.

Power take-off.

## TASK PERFORMED

The horizontal root pruner cuts off the roots of all seedlings in a nursery-bed to a depth of from 5 to 15 cm. The main purpose is to sever the tap-root of each seedling and thereby stop top growth, increase root growth potential, and increase root fibrosity.

## HOW IT WORKS

**WORKING PRINCIPLE:**

A thin, sharp, horizontal blade is drawn beneath each seedbed at a depth of from 5 to 15 cm. While progressing forward through the soil the blade oscillates from side to side. The sawing action of the sharp blade neatly cuts off the long tap root and any long deep lateral roots.

**GENERAL DESCRIPTION:**

The most common design of reciprocating root pruner in use at tree nurseries is that of the New Zealand root pruner. The design basically consists of a heavy welded steel frame that mounts to the three-point hitch of an agricultural tractor.

Two arms on pivot bearings are mounted to the unit, one on either side at the rear of the frame. A thin, flat, steel pruning blade is attached between hinge mounts on the lower end of each pivoting arm. A tie rod connecting the top end of each arm keeps the two arms synchronized to prevent wowing and buckling of the blade.

A standard shaft from the tractor's power-take-off shaft rotates a flywheel. An arm connected to an offset bearing on the rear of the flywheel connects to the left pivoting arm to impart the side-to-side oscillations to the arms and hence to the pruning blade.

To maintain operating depth the root pruner utilizes two depth-setting wheels, which run along in the pathways on either side of the nursery-bed. Each wheel is height-adjustable so that they may be locked to maintain the unit at a preset operating depth.

The design of the Lotus root pruner also incorporates a single chisel tine in front of each shaker arm to loosen the soil in advance of the arms, and reduce the mechanical strain. Often the pathway is cultivated prior to the root pruning to further ensure that the pathways are fully loosened.

**LIMITING FACTORS:**

1) Soil moisture should be close to field capacity to ensure clean cutting of the roots. The moist soil grasps the seedling root system more firmly during the cutting process.

2) Since the pruning blade must be kept very sharp, it must be changed or sharpened approximately once each hour during normal use.

3) The blade depth must be constantly monitored. The operation must progress slowly so that the operator can correct the operating depth before damaging the seedling roots.

## OPERATIONAL INFORMATION

### STAFF REQUIREMENTS:

**Operator** - One person is required to drive the tractor and maintain the proper height adjustment of the three-point hitch.

**Supervisor** - One person is required to walk beside the unit to monitor the blade-operating depth, since the tractor operator does not have an adequate view of the blade to do so.

### MAINTENANCE:

**Daily** - Sharpen or replace blades hourly under normal operating conditions.

**Special maintenance equipment required** - Blade grinding equipment or access to a machine shop for proper blade sharpening.

**Major repair items** - Blade resharpening, grinding, and replacement.

**Ease of repair** - Good. The design of the unit is straightforward and all parts are easily accessible.

**Parts availability** - Not good.

There is no North American supplier. Since parts such as blades and major bearings may need replacement, a supply of backup parts should be kept to avoid breakdown delays mid-season.

Alternatively, suitable replacement parts may have to be found or fabricated locally.

## USERS' ASSESSMENT

### ADVANTAGES:

1) The sawing action of the reciprocating pruner blade reduces pulling of the seedling roots experienced by stationary blade root pruners. The result is a decrease in root damage.

### DISADVANTAGES:

None noted.

## TECHNICAL REFERENCES

Bunting, W.R., 1984. Root Pruning and Root Wrenching. Proc. Nurserymen's Meeting, Swastika, June 1984. pp 6 - 25.

Campbell, A.J., 1985. Root Pruning and Wrenching. Proc. Nurserymen's Meeting - Orono Forest Station, June 24 - 27, 1985. pp. 26 - 31.

Lowman, B.J. , 1973. Project Record, Redesign of the Horizontal Root Pruner. U.S.D.A. Equipment Development Center No. 2234, 5 p.

**OPERATIONAL GROUP:**

**7** Spraying

**EQUIPMENT TYPE:**

**7.01** Boom Sprayers

**MAKES AND MODELS IN USE:**

1) FMC, John Bean Sprayer, Series 1000
2) Hardi, Model TR 500
   NK 170
3) Spra-motor, Model 142301
   350001
   352001
4) Calsa, Model 68-80F

Calsa trailer mounted boom sprayer in operation at St. Williams Nursery.

**MANUFACTURERS AND DISTRIBUTORS:**

1) FMC Corp.,
   John Bean Agricultural Equipment,
   2601 East Highland Drive,
   Jonnesboro, Arkansas
   72401 U.S.A.

   Distributor: G. C. Hudson Supply,
   R. R. 3,
   Brockville, Ontario
   K6V 5T3
   Telephone: (613) 342-4578

2) Hardi Inc.,
   477 Exeter Road,
   London, Ontario
   N6E 2Z3

   Telephone: (519) 685-6730
   Telex: 064-7247
   Fax: 1-519-685-6290

   Distributors: Hardi equipment can be purchased at many local farm dealerships located across Ontario. For information on dealerships in your area contact Hardi Inc.

   Note: Spra-motor Inc. no longer in business.

   Note: Calsa sprayers are no longer available in Canada. Turnco Corp., which was the Canadian distributor for this equipment, is no longer in business.

**CURRENT USERS AND NUMBER OF UNIT:**

| | Mount Type | |
|---|---|---|
| | Tractor | Trailer |
| Chapleau | 1 Spra-motor | — |
| Dryden | 2 Calsa | 2 Spra-motor |
| Gogama | 1 Spra-motor | 1 FMC |
| Kemptville | 1 Hardi | — |
| Midhurst | 1 Spra-motor | 1 Hardi |
| | 1 Hardi | — |

| | | |
|---|---|---|
| Orono | 2 Hardi | — |
| St. Williams | — | 1 Calsa |
| | | 1 Spra-motor |
| Swastika | — | 3 Spra-motor |
| Thessalon | — | 1 Spra-motor |
| Thunder Bay | 1 Calsa | 1 Calsa |

**PRICE OF CURRENT MODELS:**

| | | |
|---|---|---|
| Hardi NL/155 | 20 ft. (6 m) boom | $1,802.00 |
| | 26 ft. (7.9 m) boom | $1,926.00 |
| | 33 ft. ( 10 m) boom | $2,260.00 |
| Hardi NL/210 | 26 ft. (7.9 m) boom | $2,277.00 |
| | 33 ft. (10 m) boom | $2,611.00 |
| FMC Bean Royalette Series 1010 | | N/A |

**TECHNICAL INFORMATION**

**SPECIFICATIONS:**

| 1) Model | **Bean series 1010** | **Hardi (mounted)** |
|---|---|---|
| Pump | Piston | Hardi 1200 (diaphragm type) |
| | 45.5 L/min at 580 RPM | PTO drive |
| | PTO drive | |
| Tank | Stainless steel | Moulded polyethylene |
| | 900 L capacity | 800 L capacity |
| Chemical Agitation | Mechanical paddles in tank | Hydraulic recirculation |
| Circulation System | Enclosed line filter | Enclosed line filter Fine mesh |
| | Relief valve to control operating pressure | Pulsation damper evens out pressure fluctuations |
| | Manual controls | Manual controls |
| | | Flow proportioning maintains the rate of application regardless of travel speed |
| | | Separate valves for 3 or more boom sections |
| Boom System | Manual | Manual folding |
| | | Self-leveling |
| | | Adjustable height |
| | | Neoprene hoses and 0-rings |

| 2) Model | **Hardi (Training)** |
|---|---|
| Axle Height | Adjustable 63.5 — 86.4 cm |
| Wheel Track | Adjustable 139.7 — 254.0 cm |

**NET POWER REQUIREMENT:**

Minimum of 22 to 30 kw.

**ATTACHMENT:**

Both three-point hitch and draw-bar hitch versions are available for mounted and trailer versions respectively.

## TASK PERFORMED

Boom sprayers are used to apply herbicides, fungicides and pesticides to nursery-beds.

## HOW IT WORKS

**WORKING PRINCIPLE:**

Liquid chemical is loaded into a large tank. A pump is used to set up a circulation of the chemical. Controls accessible to the operator are used to direct the flow into piping leading to a series of exchangeable spray nozzles evenly spaced across booms on either side of the sprayer, which disperse the pressurized chemical in an even mist.

Hardi tractor mounted sprayer—Orono Nursery.

**GENERAL DESCRIPTION:**

Boom sprayers are available in either three-point-hitch-mounted or trailer versions, both of which operate on the same basic principles. The major difference between the two versions lies in the tank-holding capacity and the fact that the trailing sprayer is carried on its own wheels.

The basic configuration of all boom sprayers incorporates a large holding tank, a pump, a circulating system, and a boom and nozzle system.

The tank is usually fabricated from impact- and corrosion-resistant materials such as stainless steel or polyethylene and is shaped to minimize corners or edges within the tank that could trap residual chemical during the cleaning procedures. Mixing of different chemicals from different operations is illegal.

The circulation system is driven by a pump that may be either a roller, centrifugal or diaphragm-type unit. The pump is normally powered by a shaft from the tractor PTO, but may in some cases be powered by a separate gasoline motor.

To maintain the chemical in a thoroughly mixed state, two different techniques are employed by different manufacturers. The first method utilizes a mechanical agitator within the tank, which is usually powered by the tractor PTO or the motor driving the pump. The second method utilizes a portion of the hydraulic flow from the pump and redirects it back into the base of the holding tank. The liquid circulation so produced keeps the chemicals mixed.

The chemical distribution system of most sprayers generally follows a standard configuration. Chemical is drawn from the tank by a pump. The flow passes through a filter system to remove any impurities that could clog the spray nozzles. The flow then passes to the sprayer control unit, which is usually mounted within easy access of the sprayer operator, who in most cases is also the tractor operator. Alternatively, on some of the trailing models a second person may be positioned on an operator's seat on the sprayer.

The control unit can be a sophisticated computerized design that automatically maintains flow rates and controls the booms. More often

the controls are manual and incorporate a valve to set the amount of recirculation for the hydraulic agitator and one or more controls to regulate flow to either side of the boom or, in elaborate systems, to individual sections of the boom.

Most control units are designed to allow the pump to remain functioning throughout the operation of the sprayer, whether the boom flow is turned on or off. This feature allows the system pressure to be maintained at all times. When the controls are set to shut down flow to the booms, pressure is relieved by recirculating the flow back into the tank.

Before the flow passes on to the booms it passes through a pressure-compensating device that equalizes the system pressure between the left and right sides of the boom to ensure even distribution of the chemical.

The boom system is normally constructed of two or more folding metal frames that extend out to the sides of the unit. The frames support a series of replaceable nozzles with connecting neoprene hosing.

The spray pattern associated with the particular type of nozzle being used and the spacing of the nozzles across the booms determine how evenly the chemical is applied across the entire boom width. The pressure-compensating devices used maintain an even application rate by eliminating variations in the application rate caused by momentary variations in the sprayer system pressure. Some compensating devices also make allowances for variations in tractor ground speed.

The basic function of the replaceable sprayer nozzles is to atomize the chemical and set the dispersion pattern. The dispersion pattern and droplet size determine the application rate of a chemical. Each chemical, because of the different properties, requires a slightly different nozzle design to achieve a given application rate. For this reason the nozzles are replaceable and are available in a variety of designs.

**LIMITING FACTORS:**

1) For large nurseries, or for situations in which the spraying is typically conducted at a distance from the chemical refilling area, the smaller capacity of the mounted sprayers may be limiting. The smaller tank size may necessitate frequent returns for refills. Larger trailing versions are less likely to experience this problem.

2) Windy conditions can upset the distribution pattern of the boom sprayer and can cause the spray to drift onto other, susceptible crops.

## OPERATIONAL INFORMATION

**STAFF REQUIREMENTS:**

**Operator** - One person is required to operate the sprayer controls.

**Driver** - One person is required to drive the tractor.

Note: For most of the mounted sprayers and many of the trailing sprayers currently available, the tractor driver also adjusts and operates the sprayer controls.

**SAFETY ASPECTS:**

1) For all operations all chemicals must be registered and provincially scheduled.

| | |
|---|---|
| Pump | Diaphragm Type |
| | 22.7 — 281.9 L/min. |
| | Self-priming |
| | Corrosion-resistant |
| Tank | Polyethylene |
| | Chemical-resistant |
| | 40.6 cm filling port |
| Chemical Agitation | Hydraulic recirculation with adjustable pressure level |
| Circulation System | Manual or electric controls |
| | 3 or more boom valves for controlling individual boom sections. Each valve has a constant pressure device to maintain application rate |
| | Fine mesh inline pressure filter |
| Boom System | Manual or hydraulic lift |
| | Self-levelling to minimize spray-pattern distortion |
| | Spring-loaded boom breakaway |
| | Neoprene feed-lines |
| | Non-drip nozzle holders |
| | Cone or flat spray nozzles |

**OPTIONAL EQUIPMENT:**

The following equipment is suitable for most nursery operations and is typically available for most makes and models of boom sprayers.

1) Boom winch height adjustment.
2) Handguns for specific manual application.
3) Hose wraps and hose reels for storing hose from the handgun when it is not in use.
4) Clean water dispenser. A separate tank that holds a supply of fresh water for rinsing hands when out in the field.
5) Refill device that uses the sprayer pump to refill the sprayer tank from any convenient source of water.
6) Self-cleaning filter.
7) Multiple nozzle fittings allow quick change of nozzle types in response to weather or changes in spraying requirements between fields.

**SPECIAL MODIFICATIONS:**

1) Booms lengthened to cover five beds in a single pass (St. Williams).
2) Computer controls removed from the trailing Calsa sprayer and replaced by manual controls.

**PRIME MOVER**

**TYPE:**

Standard agricultural tractor with PTO drive.

2) All empty chemical containers, any left-over spray and all tank washings must be disposed of as per Ministry of the Environment guidelines. (See Pesticides Act and Regulations, 1987, Section 25 and 26.)

3) The operators of the spraying equipment must be thoroughly familiar with all safety precautions recommended by the manufacturers of both the spraying equipment and the chemical being sprayed.

4) When mixing and spraying chemicals the operator should wear chemical-resistant gloves, a respirator and disposable coveralls with a hood.

5) Before commencing any spraying operation, full consideration should be given to both current and forecasted weather to ensure appropriate weather conditions will prevail for the duration of the operation and for a period deemed adequate following the operation.

6) Washing equipment should always be available for the operator and for the equipment.

7) Before any spraying operation commences the operator must ensure that all personnel are at safe distances in order to avoid chemical contamination.

**MAINTENANCE:**

Washing and rinsing of the unit after each use is a key item in proper sprayer maintenance. Improper washing can result in premature corrosion of sprayer parts and possible crop damage due to spray contamination caused by residues remaining in sprayer system from previous operations.

Most manufacturers have a series of recommended winterizing procedures. Proper seasonal storage techniques are important, especially for equipment that is to be stored in unheated barns or outdoors. Improper winterizing can result in frost damage to the pump and circulation system.

**Special maintenance equipment required** - None.

**Major repair items** - Nozzle replacement.

**Ease of repair** - Very good.

**Parts availability** - Very good. Most sprayer makes currently on the market are used extensively on farms as well as on tree nurseries. Parts are therefore readily available through local equipment dealers.

**PRODUCTION RATES:**

Varies significantly with the chemical, the stock and the required application rate as determined by the nursery manager.

**USERS' ASSESSMENT**

**ADVANTAGES:**

1) Trailing sprayers have a larger tank capacity and require fewer stops for refilling. This feature is only advantageous when the nursery is quite large and/or spread out.

**DISADVANTAGES:**

None noted.

**OPERATIONAL GROUP:**

**7** Spraying

**EQUIPMENT TYPE:**

**7.02** Mistblowers

**MAKES AND MODELS IN USE:**

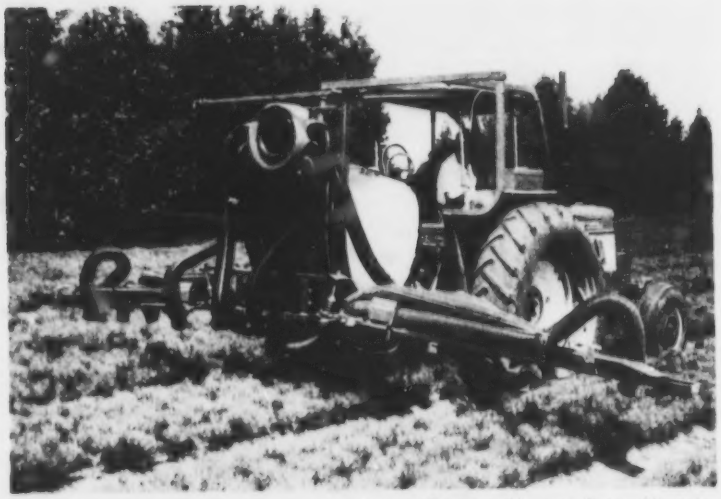
1) Hardi Incl, Mini-Mistblower,
Model NK-MINI-VARIANT.600 COSU

**MANUFACTURERS AND DISTRIBUTORS:**

1) Hardi Inc.,
477 Exeter Road,
London, Ontario
N6E 2Z3

Telephone: (519) 685-6730
Telex: 064-7247
Fax: 1-519-685-6290

Distributors: Hardi Equipment may be obtained from local farm equipment dealers in most of the farming regions of Ontario.



Hardi mistblower—Orono Nursery.

**CURRENT USERS AND NUMBER OF UNITS:**

| | |
|---|---|
| Chapleau | — |
| Dryden | 1 |
| Gogama | 1 |
| Kemptville | — |
| Midhurst | — |
| Orono | 1 |
| St. Williams | — |
| Swastika | — |
| Thessalon | — |
| Thunder Bay | — |

**PRICE OF CURRENT MODELS:**

Hardi, Model NK-MINI-VARIANT $5,589.00

**TECHNICAL INFORMATION**

**SPECIFICATIONS:**

| Model | **NK-MINI-VARIANT** |
|---|---|
| Length | - 143.6 cm |
| Width | - 160.0 cm |
| Height | - 226.0 cm |
| Weight | - 250.0 cm |
| Tank Capacity | - 400 L |
| Pump | - Model 320, Diaphragm pump |
| Pump Capacity | - 49.2 L/min |

| | |
|---|---|
| Max. Pressure | - 2413 3 kpa |
| Blower Speed | - 3800 RPM |
| Air Volume | - 184 m3/min |
| Air Velocity | - 169 Km/H |
| Power Consumption | - 13 KW |
| Misc. | - Four-stage fluid filtration |
| | - Hydraulic Venturis agitation |
| Mount | - Three-point hitch |

**OPTIONAL EQUIPMENT:**

1) Nozzle sizes — Different nozzle sizes allow adjustment of the drop size in order to suit various applications.

2) Rapid refill — Attachment allows refilling of the sprayer tank using the sprayer pump rather than an external pump.

3) Handguns — Various models available for selective applications.

4) Clean water dispenser — Unit maintains a supply of fresh water for rinsing hands and equipment while in the field.

5) Cable-operated remote control — Provides remote on/off control from within the tractor cab.

6) Live hose reels — Provides for long range hand gun operation.

7) Self-cleaning filter — Minimizes nozzle plugging.

## PRIME MOVER

**TYPE:**

Standard agricultural tractor.

**NET POWER REQUIREMENT:**

30 KW.

**ATTACHMENT:**

Three-point hitch.

## TASK PERFORMED

Mistblowers are used for low-dosage application of chemical sprays such as fungicides and for applications that require a thorough coverage of all exposed foliage with chemical.

## HOW IT WORKS

**WORKING PRINCIPLE:**

Liquid chemical is pumped to spray nozzles on retractable booms located along the rear of the unit. A high capacity blower pumps air at high speed down large diameter pipes that run to each spray nozzle. The force of the air moving past the spray nozzles atomizes the spray. The fine droplets of chemical spray carried downwards by the turbulent rush of air coat all sides of the seedling foliage with chemical.

**GENERAL DESCRIPTION:**

The Mini-variant mist blower is a three-point-hitch-mounted sprayer consisting of a tube steel frame, a tank, a pump, sprayer system and

guidelines. (See Pesticides Act and Regulations, 1987, Section 25 and 26.)

3) The operators of the spraying equipment must be thoroughly familiar with all safety precautions recommended by the manufacturers of both the spraying equipment and the chemical being sprayed.

4) When mixing and spraying chemicals the operator should wear chemical-resistant gloves, a respirator and disposable coveralls with a hood.

5) Before commencing any spraying operation, full consideration should be given to both current and forecasted weather to ensure appropriate weather conditions will prevail for the duration of the operation and for a period deemed adequate following the operation.

6) Washing equipment should always be available for the operator and for the equipment.

7) Before any spraying operation commences the operator must ensure that all personnel are at safe distances in order to avoid chemical contamination.

**MAINTENANCE:**

**Daily** - Immediately after each job, thoroughly wash and rinse the tank, systems and the tractor to prevent corrosion damage by chemical residues.

**Other**- When changing from one chemical to another, follow the decontamination procedures recommended by the manufacturer.

- Note: Cleaning should be done in a location where contaminated washings will not pollute wells, streams, or ponds.
- Change the oil in the blower gear-box every 400 hours.

**Seasonal** - Grease main shaft bearings, pump, control unit and PTO shaft at least once or twice a season.

- Follow the manufacturer's recommendations to prepare the unit.

**Special maintenance equipment required** - None.

**Major repair items** - Nozzle replacement and unclogging.

**Ease of repair** - Good. Most parts are readily accessible. Some special maintenance procedures are required in the maintenance of the sprayer pump and circulation system.

**Parts availability** - Very good. Many parts on the Hardi mistblowers are interchangeable with parts for other Hardi equipment. All parts are made by Hardi, so they can usually be readily obtained from the local equipment supplier from which the equipment was purchased.

**PRODUCTION RATES:**

1.62 ha/hour.

## USERS' ASSESSMENT

### ADVANTAGES:

1) Atomizing the chemical in a rapid air flow allows more complete coverage of seedling foliage, which is essential for fungicide applications.

2) The functional characteristics of mistblowers facilitate the application of chemicals requiring low rates of application. The chemical more efficiently reaches the foliage than is possible with a straight boom sprayer. The operator can be assured that the maximum amount of chemical is reaching the foliage with an even distribution.

### DISADVANTAGES:

1) More complex set-up and operation than a standard hydraulic sprayer.

2) The high speed air flow can cause drift of chemical sprays. This is much less of a problem with regular boom sprayers.

nozzles, an operating unit, a PTO shaft, a blower unit with associated air hoses and a spray boom.

The chemical tank holds 400 litres and is made of impact-proof, chemical-resistant polyethylene. The design is moulded to eliminate sharp corners or edges that could trap chemical residues during cleaning.

The sprayer system is powered by a Hardi 320 pump which circulates 59 L of chemical into the sprayer system each minute. The pump draws liquid from the tank through a suction filter. The flow passes through a pressure agitation unit, which recirculates a portion of the flow back into the bottom of the tank, under pressure, to keep the chemical in the tank well mixed.

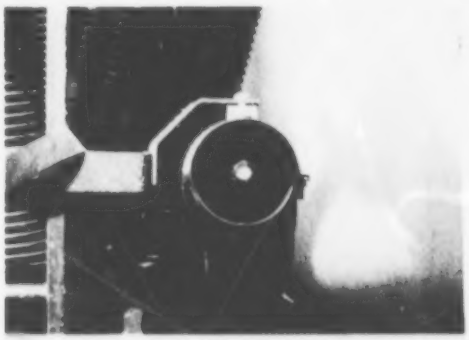
The main chemical flow continues on to a control unit which allows the operator to adjust the flow to the spray booms. The pump runs at all times during operation. When the flow to the booms is shut off, the control unit diverts the circulation back into the holding tank. As the flow to the booms is increased, return flow into the tank is decreased.

A pressure filter in-line with the flow to the boom compensates for variations in the system pressure and also equalizes the hydraulic pressure in each boom. This function is crucial for maintaining an even distribution of chemical over the width of the spray path and also along the path length as the unit progresses. Changes in system pressure caused by slight variations in engine speed would otherwise change the amount of chemical passing through the spray nozzles, hence the amount of chemical reaching the seedlings.

A unique feature of the mistblower is its use of high-speed air flow, created by a large PTO-driven squirrel-cage fan, to assist in chemical distribution. The air flow required to operate the unit is distributed evenly to each of the ten large-diameter air hoses mounted around the circumference of the fan housing. Each hose is associated with one of the spray nozzles along the boom. The air hoses each terminate at an adjustable spout, which can be swivelled to direct the airflow to suit various applications.

A spray nozzle from the sprayer system is centred within the end of each spout. The air flow rushes around the spray nozzle, picking up the droplets sprayed from the nozzle. The turbulence and speed of the air atomize the chemical sprays into a fine mist. The air currents carry the mist down around the seedling foliage, coating both top and bottom surfaces with chemical.

Closeup of the right boom showing air hoses and nozzles adjusted to spray chemical over a single bed width.



Bottom view of a mistblower nozzle showing chemical atomizing nozzle supported in the centre of the tubing.

**LIMITING FACTOR:**

1) Nozzle selection is very important for achieving the proper application rate.

## OPERATIONAL INFORMATION

**STAFF REQUIREMENTS:**

One person is required to drive the tractor and operate the mistblower controls.

**SAFETY ASPECTS:**

1) For all operations all chemicals must be registered and provincially scheduled.

2) All empty chemical containers, any left-over spray and all tank washings must be disposed of as per Ministry of the Environment

**OPERATIONAL GROUP:**

**7** Spraying

**EQUIPMENT TYPE:**

**7.03** Multi-Tool Carrier/Sprayer

**MAKES AND MODELS IN USE:**

1) Multi Tool Carrier Model 33 L

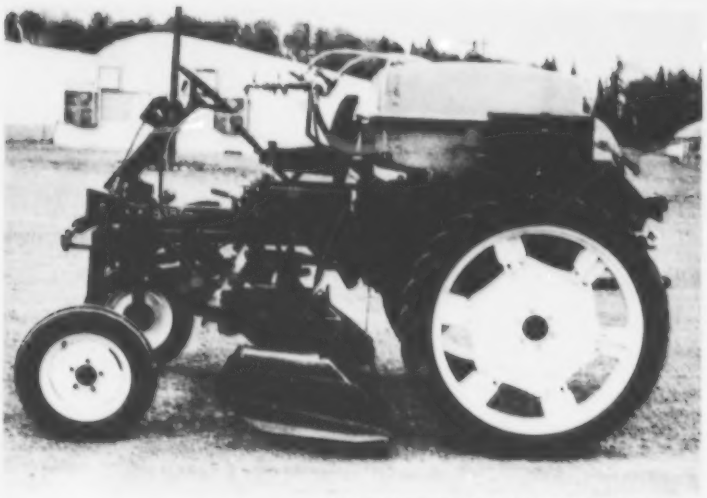
**MANUFACTURERS AND DISTRIBUTORS:**

F. M. s.r.l.,
Via Sarti, 4,
40054 BUDRIO (Bologna) Italy

Telephone: (051) 801189 - 802102
Telex: 211630 FEMABO I

Distributor: Timm Enterprises Ltd.,
5204 Trafalgar Road,
P. O. Box 157,
Oakville, Ontario
L6J 4Z5

Telephone: (416) 826-1333
(416) 878-4244
Telex: 06-982345



Multi-tool carrier equipped with Badalini path cultivators, and a sprayer tank—Swastika Nursery.

**CURRENT USERS AND NUMBER OF UNITS:**

| | |
|---|---|
| Chapleau | — |
| Dryden | — |
| Gogama | — |
| Kemptville | — |
| Midhurst | — |
| Orono | — |
| St. Williams | — |
| Swastika | 2 |
| Thessalon | — |
| Thunder Bay | — |

**PRICE OF THE CURRENT MODELS:**

| MAKE | MODEL | PRICE (1987) |
|---|---|---|
| Lombardini | 33 L | $16,963.00 |

**TECHNICAL INFORMATION**

**SPECIFICATIONS:**

**Model 33 L**

**ENGINE**

| | |
|---|---|
| Type | - 4-cycle, air cooled, diesel |
| No. Cylinder | - 2 |
| Size | - 1332 cc |
| Horsepower | - 33 |
| R.P.M. | - 3000 |

**TRANSMISSION**

| | |
|---|---|
| Forward Gears | - 6 |
| Reverse Gears | - 2 |

**GENERAL**

**PTO**

| | |
|---|---|
| (540 RPM) | - 1 |
| (1000 RPM) | - 2 |
| Travel Speed (min.) | - 1.5 km/hr |
| (max) | - 15 km/hr |
| — with reducer option | - 0.25 km/hr |
| Ground Clearance | - 60 cm |
| Min. Track | - 145 cm |
| Max. Track | - 80 cm |
| Tires — Front | - 5.0 x 15 |
| — Rear | - 7.2 x 36 |
| Weight | - 920 kg |

**OPTIONAL EQUIPMENT:**

1) Power steering
2) Speed reducer
3) Air-tight cab
4) Air conditioning

**SPECIAL MODIFICATIONS:**

1) Drop nozzle system added to the underside of the carrier to spray under nursery shades.

**COMPLEMENTARY EQUIPMENT:**

1) Pathway rototillers
2) Fertilizer spreaders
3) Pathway sprayers
4) Pipeline sprayers
5) Boom sprayers

Drop nozzles mounted on the underside of carrier frame.

Multi-tool carrier operating over a shaded nursery bed.

## TASK PERFORMED

The multi-tool carrier is a high-clearance, light-framed tractor designed to operate over high crops or bed-shading structures.

At tree nurseries the implement is ideal for maneuvering fertilizing and spraying equipment over shaded nursery-beds and for cultivating the pathways between shaded nursery-beds for weed control.

Note: The multi-tool carrier can also be used for general field spraying and path cultivation.

## HOW IT WORKS

**WORKING PRINCIPLE:**

The tool carrier operates in a similar manner to a standard agricultural tractor. The key difference is its raised frame design that gives the unit the ability to operate over the wooden nursery shades used over 1+0 stock. Its adjustable track width allows it to be fitted to the bed width used.

A rear-mounted three-point hitch and a belly-mounted tool attachment are both hydraulically operated and allow attachment of a variety of implements.

**GENERAL DESCRIPTION:**

The multi-tool carrier is a small row-crop tractor with a raised frame design. A central main frame running the length of the unit provides mounts for the engine, the operator's seat and controls, and provides attachment points for the wheel mounts and two implement mounts. There is no cowling on the frame to interfere with the operator's view.

A 2-cylinder air-cooled diesel engine mounts into the rear of the main frame and provides the unit with 24.6 kw of motive power.

All multi-tool carriers are equipped with a rear, centrally mounted PTO shaft providing 5.2 kw at 540 RPM for sprayers and granular fertilizer spreaders. The Model 33 L (available in Canada) is also equipped with front and rear accessory PTO shafts rated at 1000 rpm.

The height of the unit is factory-set to the user's requirements. The track width is user-adjustable between 145 cm and 180 cm by reversal of the wheels.

The unit is equipped with a rear-mounted, hydraulically operated three-point hitch which allows the unit to carry a variety of implements including a boom sprayer. At Swastika Nursery, when the unit is set up for use with a boom sprayer the sprayer tank is mounted on the frame above the engine just behind the operator's position. The controls to operate the sprayer are brought around to the side of the operator's position.

A second hydraulically-operated tool mount on the underside of the frame permits the carrier to be used with such implements as pathway rototillers, cultivators, seeders and furrowers. At Swastika Nursery this mount is primarily used for attaching a two-path, pathway cultivator or a drop nozzle spray bar. When used as a path cultivator, the set-up is such that the tiller heads just pass on either side of the shaded bed over which the unit is passing. The cultivation serves to weed the paths without the need for chemicals.

When the unit is set up for spraying, the front tool mount can be hydraulically adjusted in height so that the nozzles spray under the wooden shades from the open sides.

Multi-tool carrier with spray boom attachment extended.

**LIMITING FACTORS:**

1) The frame and engine construction were not designed for the heavy-duty general field work of a standard agricultural tractor, although the unit can be used for some general field activities.

**OPERATIONAL INFORMATION**

**STAFF REQUIREMENTS:**

One person required to drive the unit and operate any controls associated with any attachments.

**SAFETY ASPECTS:**

1) Operator should ensure that the unit is out of gear or the engine shut off and that all PTO-operated devices are placed out of gear before dismounting.

2) The operator should be fully aware of, and observe, all operating safety rules pertaining to the implements in use at the time.

**MAINTENANCE:**

**Daily** - General inspection of engine oil and frame.

**Weekly** - Greasing of all fittings.

- Thorough inspection for tightness of all nuts and bolts and for any cracks or broken fittings.

**Other** - Change oil at regular intervals, more often during heavy use.

**Seasonal** - Tune-up prior to operating season.

- Clean, grease and service to prepare the unit for storage.
- Check for and replace all worn or broken parts at the end of the operating season.

**Special maintenance equipment required** - None.

**Major repair items** - None identified.

**Ease of repair** - Very good; all parts are readily accessible.

**Parts availability** - Parts are available from the Canadian distributor. Since parts must come from Italy it would be wise to maintain a supply of common replacement parts or order in advance of each operating season.

**PRODUCTION RATES:**

1) Spraying shades — 2.5 to 3.0 km/hr
2) Rototilling — 2.0 km/hr

**USERS' ASSESSMENT**

**ADVANTAGES:**

1) The vehicle's exceptional ground clearance makes it ideal for operating over wooden nursery shades.

2) The unit is considerably lighter and more maneuverable than a standard agricultural tractor.

3) The operator's position right over the implements gives better visibility.

4) The presence of both a front and rear PTO as well as a second rear PTO strictly for sprayer pumps or spreader mechanisms creates an extra degree of flexibility.

**DISADVANTAGES:**

1) The low power rating and relatively light design limit the use of this unit for hauling or operating heavier agricultural implements.

**OPERATIONAL GROUP:**

**8** Transplanting

**EQUIPMENT TYPE:**

**8.01** Holland Transplanter

**MAKES AND MODELS IN USE:**

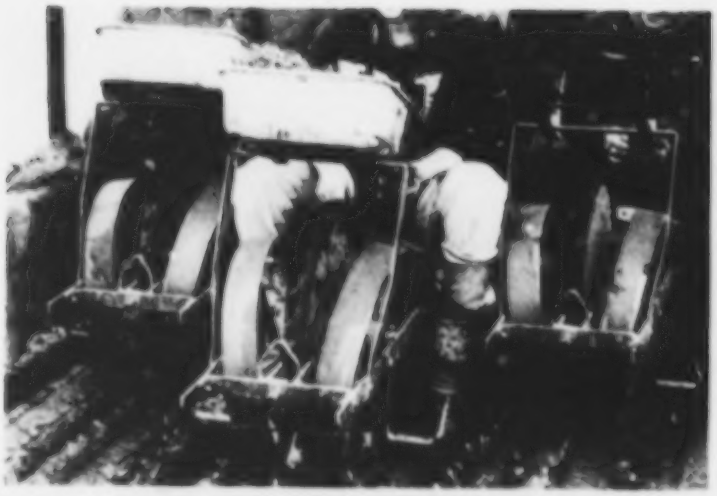
1) Holland Model 2450, Single Row Seedling Transplanter Unit

**MANUFACTURERS AND DISTRIBUTORS:**

1) Holland Transplanter Company,
510 East 16th Street,
P.O. Box 1527,
Holland, Michigan
49422 U.S.A.

Telephone: (616) 392-3579

Distributors: Purchases and inquiries should be directed through head office in Holland, Michigan.



Three Holland transplanter units in operation during a spring transplant at Orono Nursery.

**CURRENT USERS AND NUMBER OF UNITS:**

| | | |
|---|---|---|
| Chapleau | — | |
| Dryden | 3 | 8-row transplanters |
| Gogama | — | |
| Kemptville | 1 | 8-row transplanter |
| | 1 | 6-row transplanter |
| Midhurst | 2 | 8-row transplanters |
| Orono | 3 | 6-row transplanters |
| St. Williams | 2 | 8-row transplanters |
| Swastika | 8 | 8-row transplanters |
| Thessalon | 1 | 2-row transplanter |
| Thunder Bay | 5 | 8-row transplanters |

**PRICE OF CURRENT MODELS:**

1) 1 single row transplanting unit.

Model 2450 complete with coulter blade assembly and one seat $656.00.

**TECHNICAL INFORMATION**

**SPECIFICATIONS:**

**Model 2450 Seedling Transplanter Unit**

| | |
|---|---|
| Weight | - 72.6 kg |
| Seats | - Steel with backrests |
| | - Baked enamel finish |
| | - Adjustable forward, back and sideways |
| Frame | - Welded steel |

| | |
|---|---|
| Furrow Opener | - 20.3 cm |
| | - Round or blunt point |
| Packing Wheels | - 2 |
| Seedling Disc | - with rubber grippers |

**OPTIONAL EQUIPMENT:**

1) Fiber-glass or cushion seats.
2) Different Furrow opening shoes are available
   - Blunt Point, 17.8 cm
   - Blunt Point, 25.4 cm
   - Round Point
   - Polymer Furrow Opener. Model HR 1. Designed to eliminate soil buildup on outside of the shoe when soil is wet and sticky.
3) Coulter blade 30.4 cm in diameter.

**SPECIAL MODIFICATIONS:**

In order to permit the planting of multi-row seedling beds, in a single pass, the staff of each tree nursery have custom fabricated frames which allow six or eight units to operate simultaneously.

## PRIME MOVER

**TYPE:**

Agricultural tractor capable of very slow speeds (ie. 3 m/min) for sustained periods. Typically a tractor with hydrostatic drive or a tractor equipped with a reduction gear.

**NET POWER REQUIREMENT:**

Minimum of 34 kw.

**ATTACHMENT:**

The individual units are designed to be mounted in a trailing configuration from a draw-bar mounted across the rear of a tractor. It is common practice to mount six or eight units within a wheeled trailer-type frame towed by the tractor draw-bar. Some designs also require connections to the tractor's hydraulic system.

Tractor pulling the enclosed wheeled frame of a six row transplanter used at Orono Nursery

## TASK PERFORMED

The unit is used exclusively for transplanting bare-root nursery stock.

## HOW IT WORKS

**WORKING PRINCIPLE:**

A coulter blade cuts a slit into the soil surface. A wedge like a planting shoe immediately following the coulter widens the slot to accept the seedling roots.

Seedlings are placed into rubber grippers spaced around the circumference of a planting wheel, which rotates to position the seedling roots into the slot. Two angled packer wheels press the soil in around the seedling roots.

Two different techniques are used for transporting the transplanter. In the first method each unit is lifted manually and supported by chains in the raised position during transport. In the second method the units are left in their operating position at all times. During transport the tractor operator raises the entire trailer frame via hydraulic cylinders mounted between the wheel axles and the trailer frame. In both cases the transplanter units are lifted clear of the ground to prevent damage to the coulters, shoes and planting wheels.

**LIMITING FACTORS:**

1) The transplanter units require a very slow travelling speed to function properly. Standard agricultural tractors are not capable of travelling at slow enough speeds.

The main factors that limit the operating speed are:

i) Operators handling speed and accuracy - If the transplanter units are operated at too great a speed the ability of the operators to accurately place the seedlings into the planting wheel diminishes. The operators must maintain consistency in the placement of the seedlings into the grippers of the planting wheel with respect to the seedling root collar.

ii) The mechanics of the transplanter mechanism are not suited to rapid operation.

2) Too little soil compaction can result in tractor slippage.

3) Too much soil moisture can result in tractor slippage.

These effects will be more severe in transplanters utilizing deep planting shoes, which have considerably more drag than those with the shallow-style shoes.

## OPERATIONAL INFORMATION

**STAFF REQUIREMENTS:**

**Operator** - One operator is required per planting unit.

**Tractor driver** - One person is required to operate the tractor.

**Other support** - One person is required to keep the planter operators supplied with trees.

- A second person acts as crew-boss and can also help distribute seedlings to the individual planters.

**SAFETY ASPECTS:**

1) Operators must keep hands and fingers away from the gears and sprockets driving the planting wheel, and feet firmly on the foot rests.

2) It is important that the driver of the tractor and the transplanter supervisor remain in constant contact so that the transplanter can be stopped quickly in the event of an accident.

**MAINTENANCE:**

**Daily** - Thoroughly clean and inspect the units.

- Grease axles and cogs.

**Weekly** - Periodically throughout each transplanting operation (ie. Spring, Summer, Fall) check the spacing between units and ensure that the units are all planting in the same horizontal plane.

**Seasonally** - At the end of the season thoroughly clean all parts of each transplanting unit, lubricate all axles, oil all exposed metal working parts, and grease the planting shoes.

- Prior to the beginning of the spring transplant, the entire transplanter should undergo spacing checks and readjustment. Several nurseries utilize a plywood template marked out with the proper spacing for each planting unit. If required the units are adjusted to match the template. After undergoing the template check the transplanter is taken to the field to check that all units are set to the same spacing and depth.

**PRODUCTION RATES:**

15,000 - 18,000/8-hour shift/unit

Speed: 3 - 3.7 m/minute

**USERS' ASSESSMENT**

**ADVANTAGES:**

1) Operates faster than the Egedal transplanter.

2) Mechanically the units are very durable because of their very simple construction.

**DISADVANTAGES:**

1) The units are limited as to the size of seedlings that can be planted. The rubber grippers that wedge the seedlings against the planting wheel are less effective as the size of the seedlings increases.

Several individual planting units, mounted within a specially designed steel frame, permit planting a multi-row transplant bed in a single pass.

**GENERAL DESCRIPTION:**

Transplanting involves the removal of young seedlings from seedbeds or greenhouse trays and re-planting them in transplant beds. This is done to spread out the nursery stock to improve seedling growth and quality. Transplanting also provides an opportunity for preliminary grading to eliminate poorer quality or under-sized stock.

Transplanting occurs in the spring as soon as the fields are workable; in mid-summer, between mid-July and mid-August; and in the early fall, while there is still enough growing season for the roots to gain some foothold in the soil.

In Ontario, transplant beds are generally six or eight rows wide.

Individual transplanter units are suspended within a wheeled frame so that the spacing between seedling rows is even and the total bed width is approximately 120 cm, depending upon the nursery.

An individual planting unit consists of a simple welded steel frame which trails from a rigid but adjustable mount on the frame. The functioning parts of the unit consist of a coulter blade, a planting shoe, a planting wheel and two packing wheels.

The rolling coulter blade is a rotating disc that cuts into the soil surface in the vertical plane. Its prescoring action slices through any roots and debris under the surface, thereby preventing the planting shoe from becoming clogged with debris. The prescoring also reduces the wear and strain on the planting shoe.

The planting shoe is a device that extends down into the soil and acts like a wedge or double-sided plough, pushing the soil to either side to create a furrow.

The planting wheel is a steel disc with many small rubber grippers spaced evenly around its circumference. Seedlings are wedged between the grippers and the planting wheel disc so that the roots of each seedling extend beyond the edge of the planting wheel. As the planting wheel revolves, the seedling roots are suspended in the planting furrow. Two angled packing wheels push soil from both sides of the furrow in around the roots. The timing of this action is determined by a slight offset in the axis of the axles of the planting wheel and the packing wheels. Once the soil is packed around the roots, the seedling pulls free from between the rubber gripper and the planting wheel.

The operator straddles the frame, on a seat directly above the planting wheel, facing away from the direction of travel. A tray of loose seedlings is placed on a sloping stand directly in front of the operator so that the seedlings are directly above the planting wheel for quick transfer.

To transplant seedlings into the tight row spacing required by the six- or eight-row bed format used in Ontario, the transplanter units are mounted in a staggered arrangement to the cross-members of the specially designed frame.

To protect the operators from inclement weather and to minimize the effects of wind and sun on the seedlings, the entire frame is enclosed by plastic-covered walls and a roof.

The transplanter frame attaches to the tractor draw-bar. The frame is supported by the draw-bar and by two wheels mounted approximately half-way back along the frame. During transplanting, adjustments to the draw-bar and the wheels determine the level of the frame and maintain the proper transplanting depth.

Distant view of the two six row transplanters in operation with the rows of newly transplanted seedlings clearly visible.

**OPERATIONAL GROUP:**

**8** Transplanting

**EQUIPMENT TYPE:**

**8.02** Egedal Transplanter

**MAKES AND MODELS IN USE:**

1) Egedal Transplanter, Type M

**MANUFACTURERS AND DISTRIBUTORS:**

1) Egedal Maskinfabrik ApS,
Egebjerg — DK 8700 Horsens,
Denmark

Telephone 05 — 65 61 77

Distributor: Timm Enterprises Ltd.,
5204 Trafalgar Road,
P. O. Box 157,
Oakville, Ontario
L6J 4Z5

Telephone: (416) 826-1333
(416) 878-4244

Telex: 06-982345

Individual Egedal transplanter unit with an empty seedling tray—St. Williams Nursery.

**CURRENT USERS AND NUMBER OF UNITS:**

| | | |
|---|---|---|
| Chapleau | — | |
| Dryden | — | |
| Gogama | — | |
| Kemptville | — | |
| Midhurst | — | |
| Orono | — | |
| St. Williams | 2 | 6-row transplanters |
| Swastika | — | |
| Thessalon | — | |
| Thunder Bay | — | |

**PRICE OF CURRENT MODELS:**

Egedal Type M Planting Unit complete with Egedal Roller Share and tractor seat. $1695.00

Planting wheels for the Type M planting units.

| | | |
|---|---|---|
| i) | 36-finger | $ 864.00 |
| ii) | 24-finger | $ 714.00 |
| iii) | 16-finger | $ 581.00 |

Note: Prices are FOB Oakville.

**TECHNICAL INFORMATION**

**SPECIFICATIONS:**

Seats - Painted steel, standard

Frame - Steel. Construction is a combination of welding and bolting for mounting of the various parts of the transplanter unit.

Exchangeable planting wheels are available. All wheels have the same standard diameter. They differ in the number of fingers per wheel and thus the spacing.

Each planting wheel can also be set up for several different spacings.

| Wheel Type | Spacing Options (cm) |
|---|---|
| 36-Finger | 9.7, 12.9, 15.3, 17.8 |
| 24-Finger | 17.8, 20.2, 22.6 |
| 16-Finger | 33.1, 37.9, 43.6 |

**OPTIONAL EQUIPMENT:**

1) Type of planting wheel.

2) Self-propelled transplanter unit. Will hold four to seven Type M planting units and transplant a corresponding number of rows.

$ 53,203.00 — $ 60,638.00

3) Tractor drawn bed transplanter unit. Available from Egedal for transplanting four- or five-row beds using the Type M units.

$ 12,798.00 — $ 15,325.00

**SPECIAL MODIFICATIONS:**

To improve the efficiency and speed of the transplanting operation, the six units required to transplant a single six-row bed have been mounted within a nursery-fabricated trailing frame.

## PRIME MOVER

**TYPE:**

Agricultural tractor capable of very slow speeds (ie. 3 m/min.) for sustained periods. Typically a tractor with hydrostatic drive or a tractor equipped with a reduction gear.

**NET POWER REQUIREMENT:**

Minimum of 37 kw for a six-unit transplanter.

**ATTACHMENT:**

Individual transplanter units attach, via adjustable bolt on mounting fittings, to the main transplanter frame.

The transplanter frame attaches to the draw-bar of the tractor and may require a connection to the tractor hydraulics for raising and lowering the frame on the height-adjustable wheels.

## TASK PERFORMED

1) Transplanting large conifer stock. (ie. ≥ 15 cm — 3-year-old conifers.)
2) Transplanting hardwood species — 1 + 1 Hardwoods.

## HOW IT WORKS

**WORKING PRINCIPLE:**

The rolling coulters on the forward edge of the transplanter unit cut a slot into the bed surface. A wedge-like V-plough widens the slot for reception of seedling roots. Seedlings are clipped to steel fingers around the circumference of the planting wheel and are lowered root

**LIMITING FACTORS:**

1) The transplanter requires a very slow operating speed to maintain quality. This factor limits the equipment that can be used to tow the transplanter.

Factors involved with travelling speed:

i) The manual operation of transferring seedlings from the seedling trays into the clips on the transplanting wheel is very intensive. If the transplanter is operated too quickly there is likely to be an increased frequency of blank clips and a decrease in the accuracy of seedling placement.

ii) The proper mechanical function of each step in the sequence from the V-plough through to the packing and release from the clips requires slow speeds.

2) Too little soil compaction results in tractor slippage. With the drag of the transplanter the tractor wheels need to be able to grab the soil, otherwise they will tend to spin out.

Soil which is too compacted puts a considerable strain on the planting shoes that must plough through the soil. This may also produce enough drag to cause the tractor to spin out.

3) Too much soil moisture reduces the traction of the tractor drive wheels, which increases the chance of wheel slippage and spin-out under the combined drag of the planting units.

## OPERATIONAL INFORMATION

**STAFF REQUIREMENTS:**

**Operators** - One person is required for each transplanting unit.

**Tractor** - One person is required to drive the tractor, to maintain straight rows, constant speed, and maneuver the unit at the end of each row.

**Support** - One person must maintain a steady tree supply to the operators of the transplanter units.

Typically eight workers, plus supervisory staff, are involved in the operation of the six-row transplanter units at St. Williams Nursery.

**SAFETY ASPECTS:**

1) Operators should ensure that all guards are in place at all times during operation.

2) Care must be exercised to ensure that hands and clothing remain clear of the planting wheel driving gears.

3) Feet should remain on the foot rests.

4) The supervisor should be able to signal the tractor driver at all times in the event of an accident or malfunction.

**MAINTENANCE:**

The Egedal Type M transplanting units have been in use at St. Williams Tree Nursery for the past seven years with an annual usage of approximately 40 hours per year. Over this period of use there have been no notable repair items.

The complexity of the mechanics involved in the planting wheel require that particular attention be paid to the planting wheel mechanism during maintenance checks.

**Daily** - Lubricate the gears driving the planting wheel, the bearings on the planting wheel, and the angled packer wheels.

- Clean the units.
- After each pass clear all collected debris from the coulters, V-plough and planting wheel mechanism.

**Pre-Season** - Remove all storage materials.

- Adjust and align all planting units within the transplanter frame to ensure that all units are operating in the same horizontal plane and that the proper between-row spacing is being maintained.
- Lubricate all fittings and all wear points on both the units and the transplanter frame.

**Post-Season** - Thoroughly clean entire unit.

- Inspect for and replace all worn or damaged parts.
- Lubricate all fittings and oil any exposed metal surfaces to prevent rusting during storage.

**PRODUCTION RATES:**

10,000 seedlings per unit in eight hours.

## USERS' ASSESSMENT

**ADVANTAGES:**

1) The Egedal transplanter can work with larger seedlings than can a similar Holland transplanter unit. The soft rubber snaps and the positive gripping force supplied by the spring loaded clip grasp seedlings more firmly than can the simple rubber thong of the Holland planting wheel.

**DISADVANTAGES:**

1) The Egedal transplanter is typically slower than a Holland transplanter. This is mainly due to the extra time it takes to insert the seedlings into the finger clips.

2) The mechanical construction of the Egedal requires a more intensive maintenance program than a Holland transplanter because of the large number of parts that make up the complex planting wheel.

3) The operators often complain that the seedling clips are very irritating to fingers. It is difficult to avoid having the clips snap against the fingers while inserting seedlings. Blistered fingers are not uncommon.

first into the groove. Two angled packing wheels push the soil back into the trench around the seedling roots at the same instant that the seedlings are released from the finger clips.

Six planting units are mounted together in a wheeled frame in order to plant a six-row nurserybed in a single pass.

**GENERAL DESCRIPTION:**

The individual planting units are trailing-type implements designed to be clamped to a draw-bar or mounted into a frame.

The heart of each transplanting unit is the specially designed transplanting wheel. The wheel has 16, 24, or 36 fingers mounted radially around the circumference of a steel disc, which rotates on an axle set between the horizontal frame members of the unit. Individual seedlings are held against the radial fingers by spring-loaded clips. The clips snap a rubber grommet against each seedling as the seedling is pressed into the finger clip by the operator.

The transplanting wheel rotation is powered by a gear drive connection to the angled packing wheels. The transplanter wheel rotates in the same direction as the packer wheels when the transplanter moves forward.

The operating depth of the planting wheel is such that at the bottom part of its rotation the fingers extend downwards into the slot made in the soil surface by the coulters and V plough mounted ahead of the planting wheel on the frame.

Note that on the latest models of this transplanter unit, the coulters and V-plough have been replaced by an adjustable roller share which does the same job in a single operation.

At bottom center of the wheel rotation the clipped seedlings are vertically oriented and the roots suspended into the trench. Two angled packing wheels press the soil in around the seedling roots while the finger clip releases the seedling.

Each clip is mounted to a shaft that runs along the length of the metal finger towards the hub of the planting disc. A dog is attached to the hub end of each clip-shaft. When the clip closes against a seedling the shaft rotates causing the dog to protrude from the disc. At bottom dead centre of the wheel rotation the seedling is released from the clip automatically when the dog strikes a stationary arm protruding from the frame. This action causes the dog to snap back against the wheel, swivelling the shaft and opening the clip to release the seedling. This procedure repeats for each subsequent clip.

The operator faces in the direction of travel and straddles the planting wheel. The supply of seedlings is supported by a steel stand mounted over the planting wheel and in front of the operator so that the seedlings can be transferred quickly to the clips.

The weight of the frame, the units and the operators are supported by the tractor draw-bar and a set of wheels located mid-way along the frame. The planting depth is adjusted by hydraulically raising or lowering the wheels and by adjusting to the mount of each unit.

For transport the frame is raised via the hydraulic cylinders on the wheel axles. Each unit may also be swivelled above the frame for additional protection during transport.

Closeup view of the transplanting wheel showing details of the seedling clips.

Underside view of a transplanter unit showing part of the rolling coulters, the V-plough and the angled packing wheels. Note the transplanting wheel behind the V-plough.

**OPERATIONAL GROUP:**

**9** Seedling Harvest

**EQUIPMENT TYPE:**

**9.01** Seedling Lifters

**MAKES AND MODELS IN USE:**

1) Egedal, Models: SR
SRX
L
Sidedigger

2) Fobro, Model: DK 8700

Note: Fobro is currently producing the models 1000 and 1500 multi-function implements with the lifter/shaker option.

The Egedal Model SRX is the most recent version replacing the Model SR and L.

**MANUFACTURERS AND DISTRIBUTORS:**

1) Baertschi & Co. Ltd.,
P. O. Box 1,
CH — 6152 Hueswil, Switzerland

Telephone: 045 88 16 16
Telex: 86 86 25 BCHU CH

Distributor: Canadian Forestry Equipment Ltd.,
7355 Torbram Road,
Unit 15,
Mississauga, Ontario
L4T 3W3

Telephone: (416) 678-1586

2) Egedal Maskinfabrik ApS,
Egebjerg,
DK 8700 Horsens,
Denmark

Telephone (05) 65 61 77

Distributor: Timm Enterprises Ltd.,
5204 Trafalgar Road,
P. O. Box 157,
Oakville, Ontario
L6J 4Z5

Telephone: (416) 826-1333
(416) 878-4244

Telex: 06 982345

Two Egedal Model SR seedling lifters.
Unit on right has stationary lifter blade, deflector plates and shaker tines for lifting.
Unit on left is set up for root wrenching.
Dryden Nursery.

**CURRENT USERS AND NUMBER OF UNITS:**

| | | Egedal Models | | | | Fobro |
|---|---|---|---|---|---|---|
| | TOTAL | L | SR | SRX | Sidedigger | DK8700 |
| Chapleau | 2 | | 1 | 1 | | |
| Dryden | 2 | | | 2 | | |
| Gogama | 2 | | 2 | | | |
| Kemptville | 3 | | 1 | | 2 | |
| Midhurst | 4 | 2 | 1 | | 1 | |
| Orono | 2 | | | 1 | | 1 |
| St. Williams | 3 | | 1 | 1 | 1 | |
| Swastika | 3 | 2 | 1 | | | |
| Thessalon | 1 | 1 | | | | |
| Thunder Bay | 2 | | | | | 2 |

** Orono nursery currently has one Fobro lifter in addition to the Egedal SRX lifter listed.

**PRICE OF CURRENT MODELS:**

| | | | |
|---|---|---|---|
| i) Type: | SRX 1611.015 | | $6,816.00 |
| ii) Type: | L 1601.013 | | $1,606.00 |
| iii) Type: | Sidedigger | 1621.050 | $4,460.00 |
| | | 1621.060 | $4,559.00 |

Note: Price includes P.T.O. shaft.

**TECHNICAL INFORMATION**

**SPECIFICATIONS:**

| | Egedal | | |
|---|---|---|---|
| Model | L<br>1601 | SRX<br>1611.015 | Siderigger |
| Working Width | 1.10 - 1.50 m | 1.50 m | 0.5/0.6 m |
| Track Width | 1.50 - 2.00 m | 1.9/2.0 m | 2.4/2.5 m |
| Ground Clearance | 0.7 m | 0.70 m | — |
| Shaking Length | 0.781 m | 0.81/1.44 m ** | — |
| Weight | n/a | 400/500 kg ** | 260/275 kg |
| Tine Spacing | n/a | 70 m | — |

** Second figure includes the double shaking system option.

seedlings are then deposited back onto the bed surface where they may easily be pulled from the soil and collected by the lifting personnel.

For root wrenching, the tines and wide lifting share are removed and replaced with a narrower root pruning blade. The angle of the blade is fixed at 30 degrees from horizontal with the rear end high. Unlike in the lifting operation, it is the blade which oscillates during root wrenching. To accomplish this the blade is mounted on the oscillating secondary frame. The angle of the blade and the oscillation of the blade as it passes beneath the seedlings at a depth of 20 - 30 cm causes the soil to be lifted and loosened around the roots.

**GENERAL DESCRIPTION:**

The Egedal Plant Lifter consists of a heavy steel frame that is mounted on the three-point hitch of an agricultural tractor. The frame extends across the rear of the tractor then straight back along the sides of the unit to two depth-controlling wheels at the rear of the unit. The depth wheels are manually adjusted for proper operating height by placing a locking pin into one of a series of holes drilled along the length of the support arm for each wheel.

Integrated with the frame extension for the upper mount of the three-point hitch is a sheet-metal enclosure that houses a gearbox and an off-set flywheel. The gearbox transfers the rotation of the PTO shaft to a second shaft running ninety degrees to the PTO shaft, across the frame. The shaft terminates in the flywheel. As the flywheel rotates, an arm connected to an off-set bearing on the flywheel produces a forward and back motion in the arm. This motion is then transferred to the secondary pivoting frame of the lifter.

Two steel plates welded to the bottom of the side-arms of the frame form the mounts for both the lifting share and the support arms for the secondary frame. The lifting share is a wide, U-shaped sharpened steel blade. It bolts to the mounting plates on both sides of the unit, drops down and across between the side-arms. To the rear of the horizontal section of the blade a series of tines extending up and back from the blade.

To support the oscillating shaker frame, two adjustable bars extend down and back from the side mounting plates. The bars are adjustable through the bolt connections to the mounting plates. The bars terminate with two sealed bearings that connect with the pivot points on the secondary frame.

The secondary frame is a rectangular steel frame that attaches to the support arms at two pivot points along the vertical side members of the frame. The push rod from the off-set flywheel attaches to the top horizontal section of the frame. The lower half of the frame, below the pivot points, is a bolt-on section to which the long oscillating tines are mounted. When the frame rocks on the pivot points, the tines are raised and lowered in rapid succession as the frame is alternately pulled forward and pushed backward by the push rod.

The Egedal Sidedigger works in a similar fashion but is designed to lift only a single row of seedlings with each pass. The side extensions, depth-setting wheels, and secondary frame are all eliminated. The lifting blade is reduced to a U-shaped blade, 50 or 60 cm across. The lifting share is mounted off to the side of the tractor and lifter frame to eliminate all height restrictions on the stock that can be lifted. To counteract the right drag from the side-mounted lifting share during lifting, a heavy stabilizing leg extends downwards into the soil on the left side of the frame. The shaker mechanism is the same except that the push-rod from the offset flywheel now extends downwards from the

Egedal sidedigger being demonstrated at Kemptville Nursery

side-mounted flywheel to an arm connected to the shaker tines. The shaker tines hinge along the back edge of the U-shaped lifting blade. The headstock of the three-point hitch is infinitely adjustable, to allow for the alignment of the lifting share with the outer edge of the tractor tire.

**LIMITING FACTORS:**

For Root Wrenching

1) Dry soil causes the seedlings to develop a high moisture stress very quickly.
2) Wet soil is heavy and sticky and therefore resists the breaking and loosening action of the wrenching blade.

Note: For a successful root wrenching operation it is desirable to have a period of low moisture immediately following the operation in order to develop a mild state of stress upon the seedlings.

## OPERATIONAL INFORMATION

**STAFF REQUIREMENTS:**

**Operator** - One person is required to operate the tractor.

**Supervisor** - One person is required to observe the operation of the lifter to guard against seedling damage and ensure a proper lifting depth is maintained. This person is also responsible for making any adjustments to the unit.

**Support** - One person is required during root wrenching. This person maintains a sharp spare blade and assists with maintenance.

**SAFETY ASPECTS:**

1) Operator and other personnel should keep clear of all moving parts.

**MAINTENANCE:**

After each operation of the unit, sharpen the lifting blade and/or wrenching blade and grease all grease points.

Fully check bushings and associated components of the shaker mechanism.

**Major Repair Items** - Bushings on the shaker mechanism of the sidedigger models. Replacement of bushings requires one and one half hours of shop time.

## USERS' ASSESSMENT

**ADVANTAGES:**

1) The shaker mechanism incorporated into the design of the Egedal lifters allows the seedlings to be removed from the ground much more easily and with less seedling damage than when a simple straight blade is used.

2) The sidedigger lifter model places no height restrictions on the stock that can be lifted. This is because the stock being lifted does not have to pass underneath the tractor or any part of the lifter frame. This feature makes the unit ideal for some of the high-growing hardwood species.

| Model | **Fobro 1000** | **Fobro 1500** |
|---|---|---|
| Working Depth | 25 cm | 25 cm |
| Working Width | 1.4 m | 1.5 m |
| Wheel Track (outside tires) | 1.9 m | 2.0 m |
| Weight | 585 kg | 615 kg |
| Total Length | 1.98 m | 1.98 m |
| Total Width | 1.6 m | 1.8 m |
| Total Height | 1.4 m | 1.4 m |

Note: The Fobro unit has been designed as a multi-function nursery implement through a series of optional attachments. The undercutting blade and shaker platform for stock lifting are standard equipment on the Fobro wheeled tool frame.

**OPTIONAL EQUIPMENT:**

1) Double shaking system (Egedal).
2) Root pruning blade attachment.
   Available in sizes ranging from 1.1 — 1.5 meters
   Price range: $433.00 — $546.00
3) Spare front shares
   Price range: $775.00 — $1,055.00

**SPECIAL MODIFICATIONS:**

1) Two lifting tines removed.
2) Longer deflector plates installed to prevent seedlings from falling over into the pathways between beds.

## PRIME MOVER

**TYPE:**

Standard agricultural tractor.

**NET POWER REQUIREMENT:**

45 — 49 kw.

**ATTACHMENT:**

Three-point hitch.

Power take-off.

## HOW IT WORKS

**WORKING PRINCIPLE:**

All Egedal-type lifters operate on the same basic principle. A stationary horizontal lifting blade is pulled beneath the seedling bed below the root zone. The movement of the blade through the soil and the slight upwards angle of the blade to the rear lifts the bed slightly, cracking and loosening the soil around the seedling roots. As the lifted bed passes over the blade it rides up on a series of shaker tines which oscillate up and down. As the seedlings pass along the tines the vibrating action shakes loose much of the soil adhering to the roots. The loosened

Egedal Model L during lifting operation at Midhurst Nursery.

**DISADVANTAGES:**

1) Unless the sidedigger is used with a four-wheel-drive tractor, the unit has a tendency to pull the tractor to the right.

**OPERATIONAL GROUP:**

**9** Seedling Harvest

**EQUIPMENT TYPE:**

**9.02** Mechanical Tree Harvester

**MAKES AND MODELS IN USE:**

1) Hovey and Associates, 8 and 6 Row Tree Harvesters
2) Heathwood, 8 Row Tree Harvester

**MANUFACTURERS AND DISTRIBUTORS:**

1) Hovey Industries Ltd.,
   2378 Holly Land,
   Ottawa, Ontario
   K1V 7P1

   Telephone: (613) 731-1200
   Telex: 053-4922

2) Heathwood Engineering Associates Ltd.
   P.O. Box 190,
   Kirkland Lake, Ontario
   P2N 3H7

   Telephone: (705) 567-3295

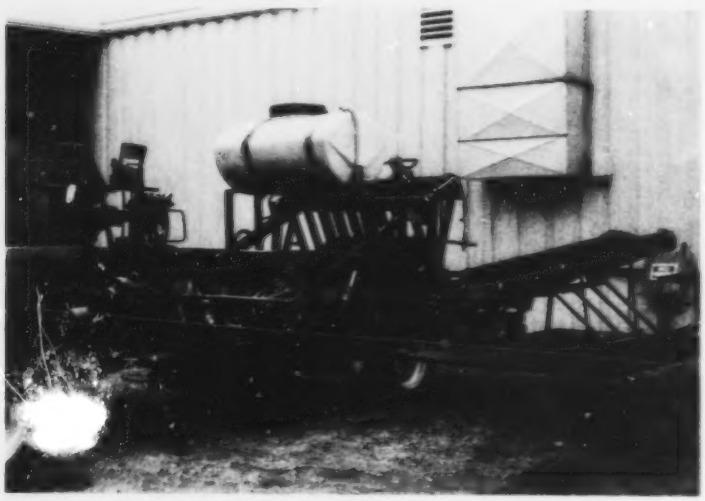
**PRICE OF CURRENT MODELS:**

1) Hovey, 8 Row Harvester $46,900.00 **
2) Heathwood, 8-Row Harvester $N/A

**NOTE: Unit is custom fitted to the users requirements. The actual price will therefore be dependent upon the options chosen.

**CURRENT USERS AND NUMBER OF UNITS:**

| | |
|---|---|
| Chapleau | — |
| Dryden | — |
| Gogama | — |
| Kemptville | — |
| Midhurst | — |
| Orono | — |
| St. Williams | — |
| Swastika | 2 (1 Heathwood, 1 Hovey) |
| Thessalon | — |
| Thunder Bay | 1 (Hovey) |



Hovey mechanical tree harvester with offloading platform and side conveyer lowered. Swastika Nursery.

## TECHNICAL INFORMATION

### SPECIFICATIONS:

Dimensions:

| | |
|---|---|
| Length | - 488 cm including tongue |
| Tongue | - 122 cm |
| Width | - 239 cm in travel position |
| Track Width | - 183 cm |
| Bed Width | - 114 cm |
| Row Spacing | - 16 cm |
| Height | - 239 cm in travel position |
| Tires | - 9.50 — 15 rib implement tires |
| Steering | - Hydraulically pivoted tongue |
| Pickup Belt System | - Foam backed double grooved powerband. |
| | - The number of pickup belts is optional, from 6 to 8 rows. |
| Root Cleaning | - Oscillating beater-bars with adjustable height and speed. |
| Material Handling | - Adjustable speed side offloading conveyor. |
| | - Side mounted hinged platform for offload and bagging personnel. |
| Hydraulic System | - PTO driven, pressure compensated, horsepower limiting variable displacement pump. |
| | - Pressure compensated valves regulate power to each hydraulic motor to compensate for load changes. |

### OPTIONAL EQUIPMENT:

1) Off-load decks.
2) Bagging carousels.
3) Conveyor system configuration.
4) Auxiliary gasoline powered hydraulic pump to replace the standard PTO-driven pump.
5) Number of harvesting rows can vary from 6 to 8.
6) Implement track width can be specified. 182 cm (72 in.) standard.

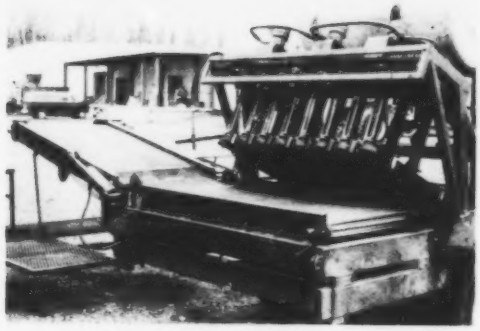
### SPECIAL MODIFICATIONS:

1) Water tank, pump, and spray nozzles were added to moisten seedlings as they pass along off-load conveyor.

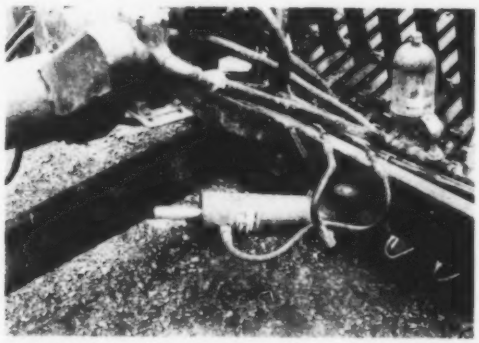
2) Detachable loading benches mounted on the loading platform make it easier for the packers by raising the tote boxes for loading.

3) Lifting belt pulley cleaners prevent excessive soil build-up which causes the belts to drop off.

4) Row guides made of steel rod were placed on either side of each lifting belt at the pickup end. The guides help to direct the seedlings to the lifting belts.



Rear view of mechanical harvester showing offloading conveyer.



View showing the hydraulic swivelling tongue used to align the pickup belts with the rows of seedlings.

Mounted below but parallel to the pickup belts is the root cleaning system. The root cleaning system consists of a series of beater-bars which oscillate from side to side along the seedling roots as the seedlings travel along the pickup belts. The beating action serves to dislodge any soil adhering to the seedling roots. To enhance this function the bars are mounted in a tapered arrangement so that they are closer together at the top end of the assembly. This causes the beating action to become more vigorous as the seedlings progress along the belt. The cleaning action can be adjusted for different soil and stock requirements via height and speed adjustments to the oscillating bars. To minimize vibration the beater assembly is constructed of lightweight aluminum alloy, high density polyethylene, and is counterbalanced.

Along the back end of the machine directly behind and slightly below the off-load end of the pickup assembly is the off-load conveyor. This conveyor transports the seedlings from the pickup belts to the side mounted off-loading platform. The conveyor is constructed of 5/8 pitch, linked steel bar belt. The conveyor extends across the back of the machine to the edge of the frame where a hinged extension extends out over a side deck. Both the side deck and hinged conveyor extension can be hydraulically raised into the vertical position to facilitate easier turning and transport.

All functions on the harvester are controlled through one of two different hydraulic systems. System one derives its hydraulic power from the tractor's hydraulic system. This system controls the cylinders for swiveling the tongue, as well as the cylinders for adjusting the height of the pickup belts and conveyor side extension.

The second hydraulic system derives its hydraulic power from a pressure compensated, horsepower limiting, variable displacement pump connected to the PTO of the tractor. This system provides the power for the hydraulic motors which drive the beater, the pickup belts, and the conveyor. The pressure compensated system ensures that any variation in the ground speed, or engine speed of the tractor will not affect the system pressure, hence the speed of the various hydraulic motors.

To control the device the operator is positioned in the front right corner of the unit facing the left side of the machine. From this position the operator can stand or sit to view the tractor operator, the personnel on the off-loading platform, and directly below, the pickup head. To the left of the operator are the pressure gauges and valves to control the speed of the belts, the beaters, and conveyor. Directly in front of the operator are the controls to swivel the tongue to align the unit with the rows of seedlings. Controls are also included to raise and lower the pickup belts, and raise or lower the side platform and conveyor extension.

**LIMITING FACTORS:**

1) Soil Conditions - Soils which are wet or of a sticky nature slow the operation of the harvester. The seedlings may not lift from the soil easily, necessitating a slower operation to prevent seedling damage and missed seedlings. Soil may be more difficult to dislodge from the roots.

2) Off-loading personnel - The volume of seedlings being transferred to the off-loading platform can be enough to swamp the packers. The off-loading personnel must be able to work quickly and efficiently to keep the machine running smoothly. Conversely the operator of the machine should coordinate the speed of the machine to maintain the flow of seedlings at a reasonable level.

3) Cold Temperatures - Cold temperatures may cause soil to freeze on moving parts such as the pickup belts and pulleys and the conveyor.

4) Nursery Bed Preparation - Improper adjustments and alignment of the transplanter units or an uneven bed surface may result in variations in row spacing that will limit the ability of the harvester to consistently gather all rows of seedlings.

## OPERATIONAL INFORMATION

### STAFF REQUIREMENTS:

**Operator** - One required to operate the harvester.

**Driver** - One required to drive the tractor.

**Mechanic** - One required on a standby basis in case there is a breakdown.

**Other Support** - Two off-load personnel to load seedlings from the off-load conveyor into large plastic tote boxes for transport to the grading barn.

Three general help to pull unlifted stock as required, handle tote boxes to and from the harvester.

### SAFETY ASPECTS:

Operator and support personnel must maintain clearance from the moving belts and conveyors.

Personnel handling loaded tote boxes should be trained in proper handling techniques to prevent unnecessary back injuries.

Eye and breathing protection may be required when operating on dry light soil conditions due to the dust created by the beater mechanism.

### MAINTENANCE:

**Daily** - Unit requires a general lubrication and inspection of belt tightness, pulleys, and the shaker mechanism to identify any potential problems.

**Major repair items** - Pickup belts have a lifetime of approximately one season or approximately 250 hours. The cost of replacing a belt is $200.00 plus labour. An eight row harvester has 16 belts which translates to an annual cost of $3200.00.

- Pulleys. The front set of 16 pulleys on the pickup head have an average life-span of one season at a cost of $416.00 for replacement. The remaining 88 pulleys must be replaced on average once every three years at a cost of $2288.00 plus labour.

In operation an average of two pulleys must be replaced per day per harvester. Pulley replacement can take 10 to 20 minutes for a idler pulley or 15 to 30 minutes for one of the nose-cone pulleys.

- Rear Conveyor. The rear conveyor on average has a lifetime of 2 years and costs $330.00 to replace.

**COMPLEMENTARY EQUIPMENT:**

Grading belt system for removing cull trees prior to final packing before storage and shipping.

## PRIME MOVER

**TYPE:**

Agricultural Tractor capable of travelling at a speed ranging from 0.4 to 0.8 km/hr. Hydrostatic drive recommended.

**NET POWER REQUIREMENT:**

37 to 45 kw.

**ATTACHMENT:**

Standard drawbar hitch.

**ADDITIONAL EQUIPMENT:**

The tractor must have a hydraulic system with rear connections to operate the pivoting tongue and implement height cylinders.

Tractor must have a mechanical PTO capable of delivering 22 kw at 540 R.P.M. to drive a hydraulic pump which operates the beaters, pick-up belts and conveyors.

## TASK PERFORMED

Harvesting bare-root transplant shippable stock.

## HOW IT WORKS

**WORKING PRINCIPLE:**

As the unit advances a series of pickup belts lift each individual row of seedlings from the bed. Each belt passes the seedling roots through a soil removal mechanism and then deposits the seedlings on a conveyor. The conveyor transfers the seedlings to the side mounted platform where the seedlings are packed and off-loaded.

**GENERAL DESCRIPTION:**

The seedling harvester developed by Hovey Industries Ltd. is a trailing device designed for lifting bareroot shippable stock from nursery beds.

The dominant feature of the harvester is the sloping pickup belt assembly consisting of 6 to 8 pickup belt units. Each pickup unit corresponds to a single row of seedlings in the nurserybed and consists of two belt and pulley arrangements placed side by side so that the surface of the two moving belts press together. The belts rotate so that the contacting surface of each belt travels at the same speed and in a direction from the front of the machine to the back, upwards along the slope from the nursery bed to the rear mounted conveyor. The belting used is 1 1/2 inches wide and backed with foam rubber which allows seedlings to be firmly grasped without causing any damage to the bark of the seedlings. The height of the pickup head is hydraulically raised and lowered so that the seedlings are grasped below the foliage just above the root collar. The alignment of the pick-up units with the rows of seedlings is accomplished by hydraulically swivelling the tongue connecting them to the tractor. This action effectively moves the head to the right and left as required.

Front view of an 8-row mechanical harvester showing row guides, sloping belt assemblies, and the water tank for moistening the lifted seedlings. Swastika Nursery.

**PRODUCTION RATES:**

Harvesting operation proceeds at an average speed of 4.7 — 6.0 metres/minute.

On average the harvester can lift from 37,000 to 47,000 trees per hour.

Operating costs using the Mechanical Harvester ranged from $18.42 to $21.14 per thousand trees lifted at Swastika Tree Nursery in 1986.

## USERS' ASSESSMENT

**ADVANTAGES:**

1) The seedling harvester eliminates much of the labour intensive work associated with manual tree lifting.

2) Cull cleanup costs following the harvest are eliminated when using the mechanical harvester.

**DISADVANTAGES:**

1) Unit will remove considerable new bud growth from the lower lateral branches of stock that has excessively flushed.

2) It is crucial that the nursery compartments in which the harvester is to operate be levelled prior to transplanting stock into the beds. If proper levelling is not done the slight unevenness of the beds cause the spacing of the rows of seedlings to be off enough to disrupt the proper operation of the harvester.

3) Areas of heavy grass or weeds disrupt the normal function of the unit.

## TECHNICAL REFERENCES

1) Barty, B., 1987, Use of the Mechanical Belt Harvester Vs Manual Lifting at the Swastika Tree Nursery, 1986, Ministry of Natural Resources.

**OPERATIONAL GROUP:**

9 Seedling Harvest

**EQUIPMENT TYPE:**

9.03 Stock Grading Belt System

**MANUFACTURERS AND DISTRIBUTORS:**

The system described in the following article is included as an example of what can be achieved with an integrated stock grading system.

This system was custom-designed by the Ministry of Government Services in 1982 in conjunction with an expansion of the shipping barn facilities at Swastika Tree Nursery.

The fabrication and installation was completed by:

Ontario Belting and Power Transmission Company,
371 Halan Road,
Woodbridge, Ontario
L4L 3T1

Telephone: (416) 851- 6651
(416) 743-7701
Telex: 065-27428

General view of one half of the grading belt system at Swastika Nursery.

**CURRENT USERS AND NUMBER OF UNITS:**

| | |
|---|---|
| Chapleau | — |
| Dryden | — |
| Gogama | — |
| Kemptville | — |
| Midhurst | — |
| Orono | — |
| St. Williams | — |
| Swastika | 1 |
| Thessalon | — |
| Thunder Bay | — |

**COST OF UNIT:**

$98,446.00 (1982, Canadian)

**TECHNICAL INFORMATION**

**SPECIFICATIONS:**

Electrical:

- CSA-approved motors designed for 208 volts, 3-phase, 60 hz operation
- Cords, #12 flexible
- Plugs, 20A, 208 volt, 3-phase
- Non-reversing magnetic starters w/two button station

Materials:

Roller Conveyors

- Gravity conveyor
- 45.7 cm wide

| | |
|---|---|
| | - Rollers 4.8 cm diameter, zinc-plated |
| | - Grease-packed ball bearings |
| | - Hot-dipped galvanized channel frame |
| | - Galvanized permanent adjustable channel supports to meet 91.4 cm elevation |
| | - Load capacity 150 kg/m |
| Belt Conveyors | |
| Belts | - 3-ply polyester P.V.C.-impregnated friction belting |
| Beds | - Flat slider bed formed of hot-dipped galvanized 12-gauge sheeting with guard rails at 45 degree angles on either side |
| Supports | - Square tubing 5.0 x 5.0 cm with 0.31 cm wall thickness |
| Drive Pulleys | - 10.1 cm diameter |
| | - Crowned and lagged, zinc-plated pulleys |
| | - 2.5 cm shaft diameter |
| Drives | - Electric motors rated at 208 volts, 3-phase, 60 hz |
| | - Power rating 0.37 to 0.75 kw |
| | - Max. belt speed 0.30 m/sec |
| | - Min. belt speed 0.10 m/sec |
| Portable Belt Conveyor | |
| | - 45.7 cm wide |
| | - 10 m long |
| | - 15 degree angle of lift |
| | - Casters and floor locks |
| | - Rough surface belting |
| Emergency Pull Cords | |
| | - Located along both sides of all belt conveyors |
| | - Poly-propylene rope supported by eye bolts |
| | - Contact limit switch |
| Scrapers | - Located on inside of each belt |
| Funnels | - 85 units |
| | - 12-gauge galvanized sheet metal |
| Misc. | - All motors, electrical controls and mechanical parts are of water-tight construction |

**COMPLEMENTARY EQUIPMENT:**

1) Mechanical tree harvesters.
2) Tote boxes for carrying stock.

## TASK PERFORMED

The stock grading system provides an efficient, rapid means of grading large volumes of nursery stock lifted by mechanical tree harvesters.

## HOW IT WORKS

### GENERAL DESCRIPTION AND WORKING PRINCIPLE:

The nursery stock grading system was designed to operate in conjunction with mechanical tree harvesters. Stock lifted by mechanical harvesters is packed into plastic tote boxes and shipped directly to the grading barn.

The tote boxes are off-loaded onto a roller conveyor that leads into the grading barn. A small stockpile of loaded tote boxes is maintained on a length of roller conveyor along the inside wall of the shipping barn. Personnel transfer the loaded tote boxes to separate roller conveyors next to each grading belt unit. This maintains a continuous supply of ungraded stock near each grading belt.

The grading belt units consist of a wide upper conveyor which forms a moving counter next to each grader and a narrow lower conveyor that forms the debris transport mechanism.

The upper stock conveyor transports bundles of graded nursery stock from the grading personnel to a common feeder belt that leads to a packing station near the seedling cold storage facilities.

The lower conveyor transports the cull and debris materials from the grading stations to a series of portable conveyors and finally to a truck parked outside the grading barn.

Twelve to fourteen grading stations are staggered along both sides of each grading-belt unit. Each station is equipped with a tote box stand, a debris funnel, and a stool. Both the stand and the funnel are mounted to the side of the conveyor frame directly in front of each grader. The stand supports a single filled tote box in front of the grader. The debris funnel directs all cull down onto the debris conveyor.

The grading personnel manually sort through the stock in each tote box, removing the cull and bundling acceptable stock in bunches of 25 seedlings.

The stock grading system in use at the Swastika Tree Nursery consists of two sets of three grading-belt units and can grade the output of up to three mechanical harvesters. A single harvester can supply enough stock to fully utilize two grading-belt units.

### LIMITING FACTORS:

1) The main limiting factor is that at present the mechanical harvesters in use at the nursery cannot harvest enough trees to utilize the entire system.

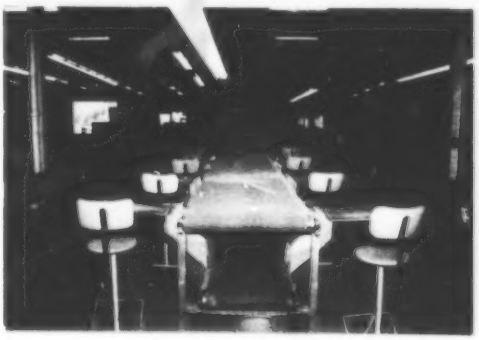
2) The production of the system, defined in packed bundles, is mainly influenced by the level of stock quality. As the amount of cull increases, the graders must spend proportionally more time removing cull and less time forming bundles of quality trees.

## OPERATIONAL INFORMATION

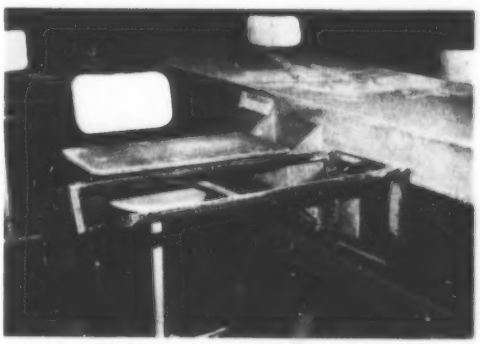
### STAFF REQUIREMENTS:

At the present time, with only two harvesters in operation at the Swastika Tree Nursery, enough stock is harvested to warrant the operation of only four of the six available grading conveyor lines. The

Incoming roller conveyer bringing loaded tote boxes into the sorting barn.



View looking lengthwise along a single grading belt unit.



A single grading station with a tote box stand, sorting platform, upper bundle conveyer, debris chute and lower debris conveyer.

following refers to the staff required for two grading lines as is typically required to grade the production of a single mechanical harvester.

| | | |
|---|---|---|
| Graders | 10 to 12 | |
| Crew-boss | 1 | Note: in full production with all six lines operating, one crew-boss would be required for each three line section of the system. |
| Tally-person | 1 | |
| Tote-handlers | 2 | |
| Packers | 3 | |
| Boxing/Shipping | 3 | |

**SAFETY ASPECTS:**

1) Graders, especially inexperienced ones, must be thoroughly instructed in safe operating procedures and be fully aware of the safety features built into the system.

2) Keep hands and fingers away from the edge of the moving belt and rollers during operation.

3) Loose clothing should not be worn by those working around or near the belt system.

**MAINTENANCE:**

Belts require continual observation and cleaning to prevent a build-up of soil.

Two to three times a season the belts should be adjusted, gear-boxes inspected, and the system lubricated.

At the end of each season the entire system should be overhauled.

**Special maintenance equipment required** - None.

**Major repair items** - Not available.

**Ease of repair** - Good.

**Parts availability** - Good.

**PRODUCTION RATES:**

An average of 240,000 seedlings of shippable bare-root stock can be graded per eight-hour shift .

For greenhouse transplants (GT) stock, an average of 600,000 G+0 seedlings can be graded in a single eight-hour shift.

Note: Both of the above figures refer to the production output of two grading lines.

**USERS' ASSESSMENT**

**ADVANTAGES:**

1) The main advantage of this system is speed.

2) The grading belt system performs a key function in a stock harvesting, handling, and packaging system built around the mechanical tree planters.

**DISADVANTAGES:**

None noted.

**OPERATIONAL GROUP:**

**10** Packaging

**EQUIPMENT TYPE:**

**10.01** Portable Bag Closure

**MAKES AND MODELS IN USE:**

1) Fischbein, Model D5
   Model E+

Note: Model ECR currently replaces the D5 and E+ series.

**MANUFACTURERS AND DISTRIBUTORS:**

1) Dave Fischbein Company,
   2700 30th Avenue South,
   Minneapolis, Minnesota
   55406 U.S.A.

   Telephone: (612) 721-4806
   Telex: 29-0963
   Cable: Fischbein

   Distributors:

   1) Bonar Packaging Ltd.,
      2390 McDowal Road,
      Burlington, Ontario
      L7R 4A1

      Telephone: (416) 827-7320
      Telex: 061-8605
      Fax: (416) 637-7167

   2) Hartwick Sales and Services,
      P.O. Box 2814,
      London, Ontario
      N6A 4H4

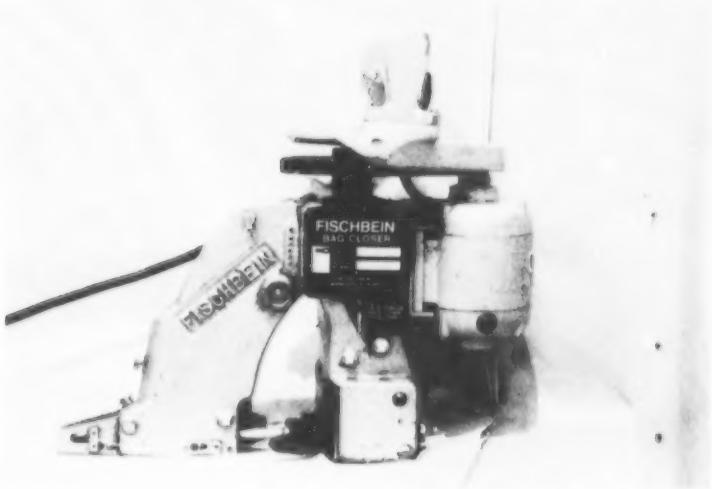
      Telephone: (519) 225-2310

**CURRENT USERS AND NUMBER OF UNITS:**

| | | |
|---|---|---|
| Chapleau | 4 | Model E+ |
| Dryden | 4 | Model D |
| Gogama | 3 | Model E |
| Kemptville | 3 | Model E+ |
| Midhurst | 4 | Model D |
| Orono | 4 | Model D |
| St. Williams | 3 | Model D |
| Swastika | 3 | Model D |
| Thessalon | 1 | Model D |
| Thunder Bay | — | — |

**PRICE OF CURRENT MODELS:**

Model ECR $910.00 — $950.00




Fischbein Model D5 portable bag closure
120 volt AC version,
Orono Nursery

## TECHNICAL INFORMATION

### SPECIFICATIONS:

**Model ECR**

| | |
|---|---|
| Weight | - 5 kg |
| Height | - 30 cm |
| Width | - 23 cm |
| Depth | - 33 cm |
| Power Requirements | |
| — AC | - 115 VAC, 1.1 amps<br>- 230 VAC, 0.6 amps |
| — DC | - 12 VDC, 9 amps |
| — Pneumatic | - 6.5 — 7.4 kg/square cm |
| | - 0.281 cu. m/min. dried air |
| Thread | - Number 12, 4 ply, high strength synthetic, nylon, or cotton thread |
| Lubrication | - Light machine oil |
| Protective coating | - Electrostatically applied powdered resin |
| Drive | - Counter-balanced eccentric drive |
| Bearings | - Hardened bronze |

### OPTIONAL EQUIPMENT:

1) Crepe-paper binding accessory.
2) Reel-type suspension units.
3) Pedestal stands.
4) Carriage conveyors.

### SPECIAL MODIFICATIONS:

Conversion of AC sewing units to DC operation.

### COMPLEMENTARY EQUIPMENT:

Twelve-volt automobile batteries may be used to operate DC-type sewing units in the field.

Small AC generating units may be used to power the portable AC units in the field.

## TASK PERFORMED

Portable sewing machines are used to stitch-seal the heavy, plastic-lined,kraft bags used to store and transport lifted seedlings destined for out-planting.

The 12-volt, battery-powered versions are normally used in the field so that the seedlings can be bundled, bagged, and sealed prior to transport to the cooler.

The AC-powered units are used primarily for sealing bags for small special tree orders that are bundled and bagged at the seedling storage facility. The AC versions may also be used for general bag closing when this procedure is not completed in the field.

## HOW IT WORKS

### WORKING PRINCIPLE:

The sewing head is supported over the folded end of a kraft bag. The operator supports the unit in one hand and guides the packed bag with the other. The head is passed along the folded lip.

As the head passes down the fold a threaded needle systematically pierces the bag leaving a weave of tightly woven thread that seals the end of the bag.

### GENERAL DESCRIPTION:

The Fischbein portable sewing machine is a lightweight industrial sewing head. The main body or framework of the head is a U-shaped metal casting. The sewing mechanism operates between the ends of the two arms of the U-shaped casting. The gap between the arms of the U forms the throat of the sewing machine.

An electrically insulated handle and finger switch is affixed to the upper part of the U. With one hand the operator supports the unit and controls its operation.

Thread is supplied from a cone spool mounted to a thread stand on the side of the unit.

In most instances the unit is driven by a 12 VDC, or a 120 or 230 VAC electric motor. The motor is contained in a dust- and moisture-sealed housing on the front of the unit. Power from the motor is transferred to the sewing mechanism through a shielded belt-driven reduction pulley system.

All of the moving parts of the sewing mechanism are sealed inside the casting. The sealed housing keeps dust and moisture from the moving parts and contains an oil bath that lubricates the mechanism.

A unique offset eccentric drive produces an oscillating motion that is transferred via levers within the housing to the needle and feed mechanisms.

The drive is counterbalanced to minimize the potential vibration from the high speed of the offset cam.

To produce a single stitch the needle pierces a hole in the heavy bag. A loop of thread on the needle is forced through the hole and across into the mechanism on the other side of the U-shaped casting. A small rotating arm called the looper grabs the loop of thread at the instant the needle is pulling back through the hole in the bag. A series of oscillating teeth, part of the feed dog mechanism, presses against the bag and moves horizontally. This feeds the bag along the sewing mechanism. With the bag now repositioned, the needle once again pierces the bag. The new loop on the needle is passed through the old loop on the looper arm, and the process is repeated to form a seal.

### LIMITING FACTORS:

1) The 12-volt field units require a heavy lead acid battery to be carried out to the bagging area, limiting the mobility of the unit.

The 120-volt AC units require a portable generator for field use, with similar limitations.

## OPERATIONAL INFORMATION

### STAFF REQUIREMENTS:

**Operator** - One person is required to operate the portable bag-sewing machine. The operator re-forms the gussets, bends the bag sharply over the contents, and passes the sewing machine across its width.

**Support** - Alternatively, one or more support personnel may speed up the operation by forming and shaping the bags in preparation for sewing.

### SAFETY ASPECTS:

Keep hands away from the moving parts of the sewing head when a power source is connected.

### MAINTENANCE:

**Daily** - Clean and oil the unit.

**Other** - Replace the needle as it becomes dull and worn.

**Special maintenance equipment required -** None.

**Major repair items** - None.

**Ease of repair** - Very good.

**Parts availability** - Good.

## USERS' ASSESSMENT

### ADVANTAGES:

1) The small size and the AC/DC voltage options give the unit a unique flexibility. The DC voltage option facilitates the use of the unit where there is no AC power source. The small lightweight unit can also run off the regular power lines, making it ideal for repacking small special orders in the packing or storage barn.

2) Portable bag-sewing units allow seedlings to be bundled, bagged and sealed in the field. Sealed bags are easier to handle and the seedlings are less likely than loose bundles of seedlings to suffer drying or handling damage in transport between the field and the cooler.

### DISADVANTAGES:

1) The car battery or small generator required to operate the portable units in the field is heavy and awkward to lug around.

**OPERATIONAL GROUP:**

**10** Packaging

**EQUIPMENT TYPE:**

**10.02** Floor-Mounted Bag Closure

**MAKES AND MODELS IN USE:**

1) Fischbein, Model 10,000, sewing head with optional flat belt conveyor, Model 800

**MANUFACTURERS AND DISTRIBUTORS:**

1) Dave Fischbein Company,
2700 30th Avenue South
Minneapolis, Minnesota
55406 U.S.A.

Telephone: (612) 721-4806
Telex: 29-0963
Cable: Fischbein

Distributors: 1) Bonar Packaging,
2390 McDowal Road,
Burlington, Ontario
L7R 4A1

Telephone: (416) 827-7320
Telex: 061-8605
Fax: (416) 637-7167

2) Hartwick Sales and Service,
P.O. Box 2814,
London, Ontario
N6A 4H4

Telephone: (519) 225-2310

**CURRENT USERS AND NUMBER OF UNITS:**

| | |
|---|---|
| Chapleau | — |
| Dryden | — |
| Gogama | — |
| Kemptville | — |
| Midhurst | — |
| Orono | — |
| St. Williams | 1 |
| Swastika | 2 |
| Thessalon | — |
| Thunder Bay | — |

**PRICE OF CURRENT MODELS:**

i) Model 10000 Sewing Head

$3,300.00 — $3,400.00

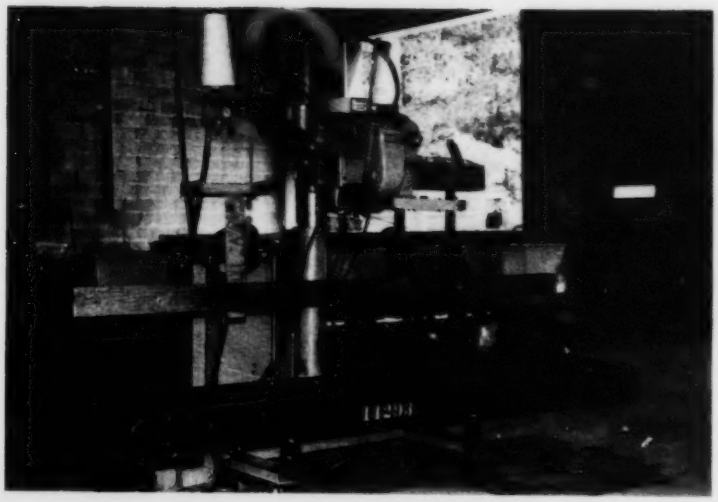
ii) Model 800 Flat Belt Conveyor

$10,927.00

$12,927.00 with hazardous areas package (i.e. explosion proof)

Note: Prices are FOB Minneapolis.

Note: Model 800 includes the Model 10,000 sewing head.



Fischbein floor mounted closure with a flat belt conveyor—St. Williams Nursery.

## TECHNICAL INFORMATION

### SPECIFICATIONS:

**1) Model 10,000 Sewing Head**

| | |
|---|---|
| Net Weight | - 26 kg |
| Stitch | - Federal type 401 |
| | - 2 Thread |
| Stitch Range | - 7 - 12 mm per stitch |
| Thread Type | - Number 12, 4-ply, high-strength synthetic, nylon, or cotton thread |
| Lubrication | - pressurized self-oiling uses light machine oil |
| General | - Sealed against dirt and dust |

**2) Model 800 Flat Belt Conveyor, with Model 10,000 Head**

| | |
|---|---|
| Weight | - 436 kg |
| Height | - 97.8 cm |
| Width | - 86.4 cm |
| Length | - 259.1 cm (Note: Length is that of the conveyor assembly. Different lengths of conveyor are available.) |
| Electrical System | - Grounded 115-volt system standard |
| | - 230 and 460 volt wiring and controls are also available |
| | - NEMA type 12 dust-tight wiring standard |
| Conveyor Belt | - Width - 30.5 cm |
| | - Length - 243.8 cm (centre to centre of end rollers) |
| | - 12.2 m/min. (belt speed) |
| | - Conveyor height-adjustable for different bag heights |
| Protective coating (finish) | - Electrostatically applied powdered resin |
| Support | - Casters under frame for mobility |

### OPTIONAL EQUIPMENT:

1) Flat belt conveyor, Model 800.
2) V-conveyor system, Model 800 V.
3) Power driven in-feed, Model 4380.
4) Photo electric actuator assembly, Model 1790, for use with power-driven in-feed.
5) Air automatic actuator/cut-off, Model 1725. This option is used in hazardous areas.
6) Bag coder, Model 5325.
7) NEMA type 0 hazardous location wiring.
8) Sewing pedestal, Model 400.
9) Tape binding accessory, Model 800T.

## TASK PERFORMED

The primary function of the floor model sewing machine is for stitch-sealing the open end of the heavy, plastic-lined kraft bags used to store and transport lifted seedlings destined for out-planting.

## HOW IT WORKS

### WORKING PRINCIPLE:

Seedlings are bundled and packed into heavy, plastic-lined kraft bags. The plastic lining is twist-tied to prevent drying. Each bag is folded, aligned and passed through the sewing head to produce a tight weave of thread across the fold that provides a strong seal. The seedlings are contained for ease of handling and to prevent damage and moisture loss during storage and transport.

### GENERAL DESCRIPTION:

The Fischbein Model 10,000 sewing head is an industrial sewing machine designed for applications that require the creation of strong, stitched joints in cloth, plastic or heavy paper materials.

The sewing head assembly, which forms the heart of the sewing system, is a sealed metal casting which encloses the major moving parts of a precision-built sewing mechanism. The housing is sealed against dust, dirt, and other foreign particles and also contains a pressurized oil bath to provide lubrication.

The Model 10,000 sewing head produces a double-thread stitch that consists of a series of interwoven loops of thread. The loops are pulled tight by thread tension. The tight, linear weave of thread extends across the width of the bag, firmly sealing the opening.

In order to take advantage of the speed of the head, it has been designed to be incorporated into assembly lines. Optional conveyors, pedestal mounts and other automated labour-saving devices are available.

The Model 800 flat belt conveyor is designed to mount below a sewing head suspended from a pedestal mount. The conveyor automatically feeds filled bags through the head for sewing.

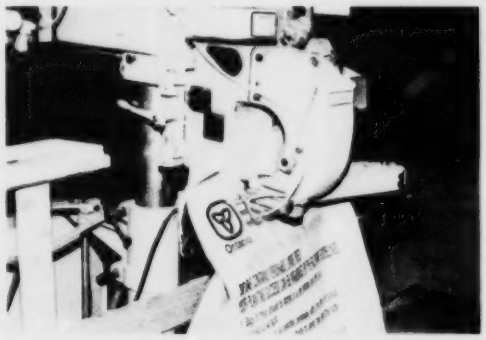
The operator places the straightened bags on the conveyor one after another and monitors the passage of each bag through the head to ensure that the bag is arranged neatly for a proper joint.

The conveyor is height-adjustable so that all sizes of filled bags will be supported at the proper height so that the seam is placed the proper distance from the top of each bag.

After bags have passed through the head they are moved to the cold room to await transport.

### LIMITING FACTORS:

1) Wet Bags — When bags are packed in the field during wet weather the kraft paper becomes wet and does not feed through the head well, slowing the sewing operation.
2) Operator — (i) To achieve a proper, strong seal the operator must neatly fold the bags.
   (ii) The more experienced the operator the greater will be the efficiency and speed of the entire sewing operation.



Fischbein Model 10,000 sewing head in process of sealing a Kraft-poly bag loaded with seedlings.

## OPERATIONAL INFORMATION

### STAFF REQUIREMENTS:

**Operator** - One person is required to straighten and prepare the open end of each bag and to pass the bag through the sewing head.

**Support** - Five people retrieve and move filled bags to and from the conveyor.

### SAFETY ASPECTS:

1) Ensure that all guards and safety devices are in place prior to operation.

2) Keep hands away from the moving parts of the sewing head when a power source is connected.

### MAINTENANCE:

**Daily** - Clean and oil the unit.

**Other** - Replace the needle as it becomes dull and worn.

**Special maintenance equipment required** - Service personnel from the distributors will set up a seasonal service schedule for tune-up and general maintenance.

**Major repair items** - None.

**Ease of repair** - N/A.

**Parts availability** - Good.

## USERS' ASSESSMENT

### ADVANTAGES:

1) The sewing unit provides a fast, efficient means of sealing bags of nursery stock. Sealing bundles of seedlings within heavy bags makes handling much easier and prevents seedling loss. The heavy kraft paper and plastic lining provide physical protection from handling damage and also decrease the risk of excessive moisture loss during transport and storage.

2) All bagging is done inside in a dry area, which reduces sewing problems possible when bagging seedlings in the field in wet weather.

### DISADVANTAGES:

1) The floor model bag sewing unit is restricted to use within an enclosed building with a suitable source of AC current.

Although the unit is equipped with casters that allow it to be moved within a building, its size and weight render it relatively immobile so that it is generally located conveniently near the cold room or near the entrance from the field.

**OPERATIONAL GROUP:**

**11** Seedling Storage

**EQUIPMENT TYPE:**

**11.01** Cold Storage Facilities

The following article describes the seedling storage facility at the G. H. Ferguson Forest Station at Kemptville, Ontario. Although seedling storage facilities vary from nursery to nursery, the basic design considerations and equipment are similar.

The design and construction of any seedling storage facility requires the knowledge and expertise of an engineering firm.

Cold storage facility.

**CURRENT USERS AND NUMBER OF UNITS:**

| | |
|---|---|
| Chapleau | — |
| Dryden | — |
| Gogama | — |
| Kemptville | 1 ** |
| Midhurst | 1 |
| Orono | 1 |
| St. Williams | 1 |
| Swastika | 1 |
| Thessalon | — |
| Thunder Bay | 1 |

** Facility described in the following article.

**TECHNICAL INFORMATION**

**SPECIFICATIONS:**

| | |
|---|---|
| Length | - 24.4 m |
| Width | - 11.6 m |
| Height | - 4.0 m |
| Construction | - Poured concrete floor<br>- Steel I-Beam construction<br>- Insulated walls and ceiling<br>- Aluminum siding exterior<br>- Plywood interior<br>- Lifting garage doors for access<br>- Plastic strip inner-door air barrier |
| Environmental Control | - 2 Blanchard-Ness cooling unit Model CUD - 150 H2<br>- 6 fan units<br>- Honeywell temperature controller Microik 100 Q642J<br>- K-step controller K7420A<br>- Honeywell thermometer recorder with cooler probes<br>- Heating units |

**COMPLEMENTARY EQUIPMENT:**

1) Stacking pallet racks to facilitate handling and stackability of the bagged seedlings.

2) Fork lift to stack and move pallet racks when loading or unloading bagged seedlings from the cooler.

**TASK PERFORMED**

**Over-winter frozen storage** — Seedlings are lifted and bagged in the fall. The bagged seedlings are kept in the coldroom at simulated winter conditions until the spring planting season commences.

**Spring cool storage** — Seedlings lifted in the spring lift are bagged and placed in the cool room. The cool conditions maintain stock dormancy and thereby inhibit growth prior to shipping and planting. The cool conditions extend stock freshness during the waiting period preceding shipping.

**HOW IT WORKS**

**GENERAL DESCRIPTION AND WORKING PRINCIPLE:**

The storage of lifted seedlings requires a large volume coldroom. Coldroom design and construction varies from nursery to nursery in response to differences in stock types, production levels, local climate, packaging and storage arrangements.

The facility at Kemptville Nursery consists of two self-contained buildings. Each cold storage building has a poured concrete floor and a steel I-beam frame, enclosed by highly insulated walls with aluminum siding exterior and plywood interior.

Access to the coldroom is through large, folding, garage-door-style, vehicle-access doors. To minimize the entrance of warm outside air during loading or unloading of the cooler, all access openings are equipped with clear plastic-strip air exchange barriers.

Environmental control equipment for this and all other coldroom facilities is geared to consistently maintaining conditions suitable for seedling storage. For over-winter frozen storage, cooler conditions must simulate frozen field conditions with an interior temperature between 0 and -2.5 degrees C. For spring cool storage, cooler conditions must be sufficient to maintain seedling dormancy, between 0.5 and 2.0 degrees C.

Environmental control of each coldroom is achieved by a combination of heating, cooling, and air circulation. Two high-capacity cooling units pump heat out of the coldroom. A series of heating units inject heat into the room, when necessary, to prevent the temperature from dropping below acceptable levels. Large circulating fans keep the air within the room moving and well mixed so that the environmental conditions will be uniform throughout the entire room.

**LIMITING FACTORS:**

1) The interior dimensions of the Kemptville facilities do not allow maximum space utilization with the pallet racks that are currently being used. The stacking equipment and packaging methods have changed since the facility was constructed. This points out the importance of considering the method of packaging, the type and size of stacking racks that are to be used, and the stacking arrangement when designing a seedling storage facility.

2) Interior illumination is important for both safety and proper visibility when working within the cooler. The interior walls should be painted a light colour and the lighting should be designed to operate efficiently under the cold conditions within the cooler.

## OPERATIONAL INFORMATION

### STAFF REQUIREMENTS:

**Operator** - One person is required to monitor, daily, the environmental conditions within the cooler and make appropriate adjustments to the controls.

**Maintenance** - Most maintenance work, particularly involving cooling units, is contracted out to refrigeration specialists.

### SAFETY ASPECTS:

1) Care must be exercised when stacking pallets in the cooler. Improper stacking may cause the pallets to topple unexpectedly, causing personal injury.

2) The storage room should be equipped with emergency lighting to provide illumination to personnel within the cooler if the power is cut off unexpectedly.

### MAINTENANCE:

Basic maintenance activities include a yearly overhaul of the environmental control equipment, normally conducted before the fall lift in preparation for winter storage of stock as frozen over-winter storage.

**Special maintenance equipment required** - Specialized tools and materials are required to maintain the refrigeration units.

**Major repair items** - Compressors in the cooling units.

**Ease of repair** - The specialized knowledge of cooling consultants is required to properly maintain and repair cooling units.

**Parts availability** - Dependent upon the local supplier. Can take considerable time to acquire parts for some makes of cooling equipment.

## USERS' ASSESSMENT

### ADVANTAGES:

1) Lifting and packaging some of the stock in the fall gives the nursery a head start on the spring lift so that more stock can be shipped out before the seedlings flush out in the spring. The controlled environment of the coldroom with simulated winter field conditions allows stock to be maintained at optimum conditions for survival and also for maintenance of the required winter dormancy.

2) When used as a cooler during the spring shipping season the seedling cool storage facilities keep the lifted stock cool and fresh. By cooling the stock sufficiently, the winter dormancy of the seedlings can be maintained, allowing more time for shipping before seedlings flush out.

### DISADVANTAGES:

None noted.

**OPERATIONAL GROUP:**

**12** Research and Control

**EQUIPMENT TYPE:**

**12.01** Scales and Balances

**MAKES AND MODELS IN USE:**

| | |
|---|---|
| Aurora Scale Company | TW 2610 |
| Howe Richardson Inc. | SSD800<br>5412 |
| Mettler | PC2200<br>PC400 |
| Ohaus | 1119 D<br>720 |
| Sartorius | L610D<br>1265MP<br>3862MP8<br>U5000D<br>U5500E |
| Toledo Scale Company | 4644 |

**MANUFACTURERS AND DISTRIBUTORS:**

1) Aurora Scale Manufacturing Ltd.,
230 Edward St.,
Aurora, Ontario
L4G 3L6

Telephone: (416) 727-5892

2) Howe Richardson Inc.,
3219 Wharton Way North,
Mississauga, Ontario
L4X 2B6

Telephone: (416) 625-9214

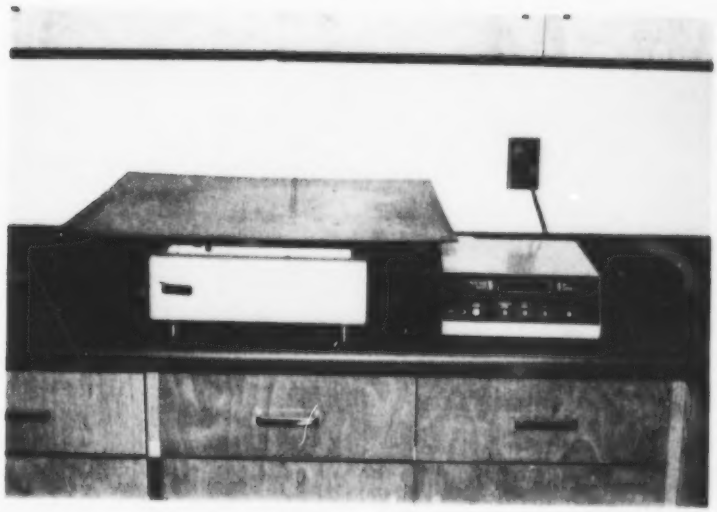
Telex: 06-961221

3) Mettler Instrument Corporation,
P.O. Box 71,
Hightstown, New Jersey
08520 U.S.A.

Telephone: (609) 448-3000

Distributors: Fisher Scientific,
120 Denison St.,
Unionville, Ontario
L3R 8G6

Telephone: (416) 479-8700



Heavy duty electronic scales.

4) Ohaus Scale Corporation,
29 Hanover Road,
Florham Park, New Jersey
07932 U.S.A.

Telephone: (201) 377-9000

Distributors: 1) Fisher Scientific,
120 Denison St.,
Unionville, Ontario
L3R 8G6

Telephone: (416) 479-8700

2) Canadian Laboratory Supplies,
2390 Argentia Road,
Mississauga, Ontario
L5N 3P1

Telephone: (416) 821-9660

Fax: (416) 858-6374

5) Sartorius GMBH,
Weender Landstrabe 94-108,
3400 Goettingen, West Germany

Telephone: (0551) 308-1

Telex: 96723

Fax: 308 289

6) Reliance Electric Ltd.,
Roledo Scale Division,
5220 Creekbank Drive,
Cooksville, Ontario
L4W 1X1

Telephone: (416) 625-8112

**CURRENT USERS AND NUMBER OF UNITS:**

| | | |
|---|---|---|
| Chapleau | 1 | Mettler Electronic |
| Dryden | 2 | Ohaus Triple Beam |
| | 1 | Sartorius Electronic |
| Gogama | 2 | Ohaus Triple Beam |
| Kemptville | — | |
| Midhurst | 1 | Toledo Torsion Balance |
| | 1 | Ohaus Triple Beam |
| | 2 | Sartorius Electronic |
| Orono | 1 | Aurora Triple Beam |
| | 1 | Sartorius Electronic |
| St. Williams | 1 | Howe Richardson Electronic |
| | 1 | Mettler Electronic |
| Swastika | 1 | Ohaus Triple Beam |
| | 1 | Sartorius Electronic |
| Thessalon | 1 | Sartorius Electronic |
| Thunder Bay | 1 | Aurora TW2610 |
| | 1 | Sartorius Electronic |

**OPTIONAL EQUIPMENT:**

1) Standard weight sets. Primarily for mechanical balances.
2) Scoop-type scale platform.
3) Calibration weights.
4) Draft shields.

Electronic Scales Only:

5) Digital interfaces.
6) Data input/output, programming keyboards.
7) Printers.
8) Program modules to set up scales for specific laboratory tasks.

## TASK PERFORMED

Small capacity laboratory or bench-type scales and balances, generally ranging up to approximately 5500g capacity, are standard equipment in nursery laboratories. Scales in this category are used for all general-purpose weighing involved with chemical analysis and sample testing for stock quality control and soil research.

Larger capacity scales with weight ranges of up to 10 kg and over are used for tasks such as weighing seed and seed-coating chemicals during preparations for seeding or for weighing powders when mixing insecticides.

## HOW IT WORKS

### GENERAL DESCRIPTION AND WORKING PRINCIPLE:

In general the scales and balances currently in use at Ontario tree nurseries can be classified into two basic categories: mechanical and electronic.

Toledo Torsion Balance.

### MECHANICAL BALANCES:

The mechanical balances include torsion balances and triple-beam balances. These devices rely upon the simple mechanical principles of levers, fulcrum points, or the tension exerted by twisting wires or springs. These instruments function by balancing the weight of the object against a series of reference weights or against a known and equivalent mechanical force.

A typical mechanical balance has a weighing platform mounted on the end of a beam balanced on a knife-edge fulcrum point. An object or material placed on the platform pushes down on the end of a beam and thereby throws the beam off balance. Standard weights are added to one end of the beam opposite the platform until the beam is once against balanced on the fulcrum point. The weights are totalled to obtain the weight of the object.

The common triple-beam balance eliminates the need for adding standard weights by modifying the balancing beam. Sliding weights corresponding to the coarse, medium and fine weight ranges are moved along graduated scales to obtain the object weight.

The triple beam works on the principle that as a given weight is moved out from the fulcrum point along a beam it produces an increasing amount of lifting force on the portion of the beam on the opposite side

of the fulcrum. In other words the weight needed to balance the beam increases as the sliding weight is moved towards the end of the beam.

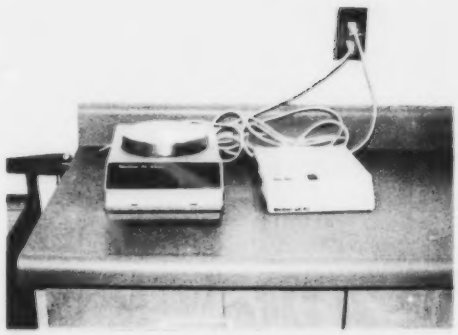
Note that there are many variations in the design of mechanical scales and balances but the basic principle of balancing weights or forces is common. Some of the design variations suit special-purpose applications while others make the scales more convenient (e.g., displays the weight on a graduated analogue dial).

**ELECTRONIC SCALES:**

Electronic scales, unlike mechanical scales, generally have few moving parts. These scales are constructed around a solid state device known as a load cell. The load cell is a semi-conductor crystal that produces a voltage potential when placed under pressure.

Weight placed on the scale platform is directed into the load cell. Electronic circuitry in the scale reads the voltage potential produced and converts in into digital information that accurately corresponds to the weight of the object on the scale platform.

Electronic scales often include features impossible or difficult to obtain on mechanical scales. The weights can be displayed on easy-to-read digital displays. The electronic circuitry can be designed or programmed to convert between different measuring units, to convert weights into counts (e.g. numbers of seed in a sample), to automatically adjust the scale to the proper weight range, or to compensate for adverse scale operating conditions (e.g. vibrations). Digital information can be read directly by computers and printed or stored on electronic storage media for subsequent analysis.



Light duty electronic scales with optional printer attachment.

**LIMITING FACTORS:**

1) In general, scales designed with a high maximum weight suffer from a decreased sensitivity at the lower weight ranges. On the other hand if the scales have too low a maximum weight they may frequently become overloaded. Dividing materials into smaller lots for multiple weighing increases the time required to weigh materials and increases the opportunities for weighing error.

## OPERATIONAL INFORMATION

**STAFF REQUIREMENTS:**

One person.

**SAFETY ASPECTS:**

When used to weigh dusty substances, particularly pesticides, a ventilation hood is required.

**MAINTENANCE:**

**Daily** - Clean the platform to maintain accuracy.

**Seasonal** - Check scales for accuracy.

The complexity of these devices and the need to ensure accuracy and precision in the weighing results makes it mandatory that qualified service personnel be used for any major repair and maintenance activities.

## TECHNICAL INFORMATION

### SPECIFICATIONS:

A complete listing of the specifications for all scales and balances currently in use is beyond the scope of this catalogue.

The following specification listings were chosen as typical of the equipment used at many of our tree nurseries.

| SPECIFICATIONS | SCALES AND BALANCES | | | |
|---|---|---|---|---|
| Make | **Mettler** | **Mettler** | **Sartorius** | **Sartorius** |
| Model | **PM 400** | **PM 2000** | **L610D** | **U5000D** |
| Weight Range (g) | 410 | 2100 | 60/606 | 500/5050 |
| Readability (g) | 0.001 | 0.01 | 0.001/0.01 | 0.01/0.1 |
| Tare Range (g) | 0 - 410 | 0 - 2100 | 0 - 606 | 0 - 5050 |
| Standard Deviation (+/-g) | 0.002 | 0.002 | 0.001/0.01 | 0.01/0.1 |
| DIMENSIONS (mm) | | | | |
| Sample Platform | 130 diam. | 150 diam. | 130 diam. | 235 x 180 |
| Housing Depth | 315 | 315 | 220 | 250 |
| Width | 195 | 195 | 235 | 270 |
| Height | 67 | 67 | 60 | 65 |
| Power Requirements | 120 VAC | 120 VAC | 120 VAC | 120 VAC |

| Make | **Sartorius** | **Richardson** | **Ohaus** | **Ohaus** |
|---|---|---|---|---|
| Model | **3862 MP8** | **5412/SSD800** | **1119D** | **720** |
| Weight Range (kg) | 16.5 | 99.99 | 20.0 | 2.61 |
| Readability (g) | 0.1 | 100.0 | 1.0 | 0.1 |
| Tare Range (kg) | 0 - 16.5 | 0 - 99.98 | 0 - 2.27 | None |
| Standard Deviation (+/-g) | 0.15 | — | 1.0 | 0.1 |
| DIMENSIONS (cm) | | | | |
| Sample Platform or scoop | 24.0 x 29.5 | 64.0 x 64.0 | 28.0 diam. | 15.2 diam |
| Housing Depth | 41.0 | 30.0 | — | — |
| Width | 25.0 | 28.0 | — | — |
| Height | 12.5 | 12.0 | — | — |
| Power Requirements | 120 VAC 60 Hz | 115 VAC 50 - 60 Hz Rechargeable Self contained DC Battery | None | None |

## USERS' ASSESSMENT

### ADVANTAGES:

1) Mechanical balances are particularly suited to purposes that do not require many repetitive measurements or exceptional precision. For occasional use in weighing out seedlots or bulk chemicals many mechanical balances are quite suitable.

2) Electronic scales are ideal for repetitive laboratory sample measurements where speed, fine accuracy, and/or computer data analysis of the information gathered is required.

3) Electronic scales offer a host of features not possible on mechanical beam balances.

— digital readout

— computer interfaces

— self-balancing and self-testing functions

— automatically adjustable weight ranges

— automatic scale adjustment to allow for debris buildup on the scale platform.

### DISADVANTAGES:

1) The large mechanical balances are non-portable. These units are usually quite heavy and require very careful adjustment to set-up.

2) Mechanical balances in general are not as quick and easy to operate as the newer electronic versions. Normally mechanical balances require adding up weights manually or reading analogue dials or scales. Electronic scales use digital readouts that can display the results in various units.

**OPERATIONAL GROUP:**

**12** Research and Control

**EQUIPMENT TYPE:**

**12.02** pH Meters

**MAKES AND MODELS IN USE:**

1) Canlab Portable, Model 607
2) Plant Products Ltd. Model PT70

**MANUFACTURERS AND DISTRIBUTORS:**

1) Canlab,
   2390 Argentia Road,
   Mississauga, Ontario
   L5N 3P1

   Telephone: (416) 821-9660

2) Plant Products Co. Ltd.,
   314 Orenda Road,
   Brampton, Ontario
   L6T 1G1

   Telephone: (416) 793-7000

   Telex: 06-97595

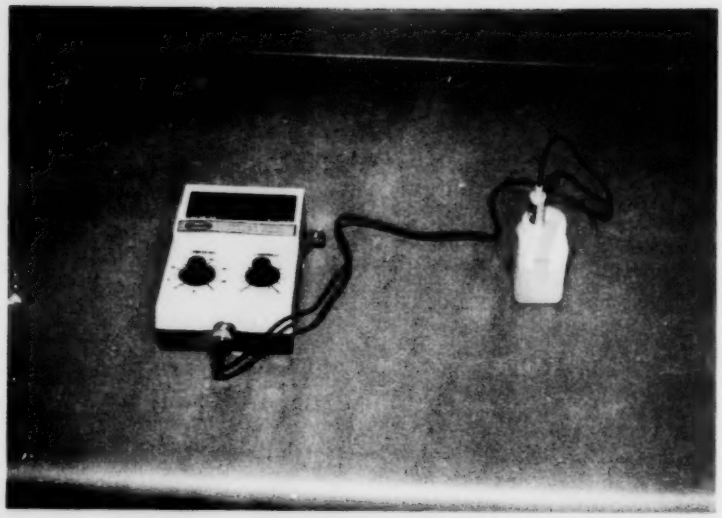
   Fax: (416) 793-9157

**CURRENT USERS AND NUMBER OF UNITS:**

| | |
|---|---|
| Chapleau | — |
| Dryden | — |
| Gogama | — |
| Kemptville | — |
| Midhurst | 1 |
| Orono | 1 |
| St. Williams | 1 |
| Swastika | — |
| Thessalon | 2 |
| Thunder Bay | 1 |

**PRICE OF CURRENT MODELS:**

| | | |
|---|---|---|
| Canlab | 607 (H5503-1) | $329.28 |
| Plant Products | PT 70 (65110) | $470.38 |



Portable pH meter.

## TECHNICAL INFORMATION

### SPECIFICATIONS:

| | Canlab | Plant Products |
|---|---|---|
| Range (pH) | 0 - 14 | 0 - 14 |
| Accuracy (pH) | ± 0.03 | N/A |
| Resolution (pH) | 0.05 | 0.5 |
| Temperature Compensation | 0 - 100 | 5 - 40 |
| Readout | 8 mm | 7.6 cm |
| | L.E.D. ** | Analogue |
| Power Requirement | 6 AA Batteries | 2 x 9 volt |
| | or 110 volt w/adaptor | transistor batteries |
| Size: | | |
| - Length | 14 cm | 15 cm |
| - Width | 9 cm | 10 cm |
| - Depth | 4.8 cm | 5 cm |
| General: | 1 combination | 1 combination |
| | Electrode | Electrode |
| | reference solutions incl. | reference solutions incl. |

** LED: Light-emitting diode, digital display.

## TASK PERFORMED

Portable pH meters are used to determine the chemical pH of solutions in laboratory analysis of nursery soils and nursery stock.

## HOW IT WORKS

### GENERAL DESCRIPTION AND WORKING PRINCIPLE:

The portable pH meters used at Ontario tree nurseries are small battery-powered devices consisting of a small hand-held or table-top case and a pH-measuring probe.

The case houses a digital or analogue pH-calibrated readout, electronic circuitry, a DC power source (batteries or a connection to a 12-VDC power supply), and controls for calibrating and operating the meter.

The pH probe is a plastic cylinder, with the bottom end open, protecting a specially designed device inside the probe that quantifies the hydrogen ion concentration of solutions.

When the probe is inserted into a solution some of the solution enters the probe through the open end. Hydrogen ions from the solution pass through a semi-permeable membrane into a standard neutral solution contained within the probe. Ions continue to pass through the membrane until the concentration of hydrogen ions within the probe solution is in equilibrium with the solution being tested.

The concentration of hydrogen ions in the standard solution within the probe is directly related to the conductivity of the standard solution. A small electric current is passed between two electrodes inserted into the compartment containing the standard solution. The level of current flow between the two electrodes is measured by the electronic circuitry of the meter and converted to a corresponding pH value relative to pH readings of standard reference solutions tested during calibration of the unit.

## OPERATIONAL INFORMATION

### STAFF REQUIREMENTS:

One person is required to operate the pH meter and prepare the solutions for measurement.

### MAINTENANCE:

The manufacturers recommend special short-term and long-term storage procedures to protect the probe from drying out.

As the probe becomes coated with dirt or chemical residues it will require cleaning procedures ranging from simple vigorous rinsing for loose debris to chemical treatment for removal of organic or hard coatings.

As the probe ages the manufacturers recommend reconditioning it using a series of chemical treatments, to improve the accuracy and response time of the electrode.

**Special maintenance equipment required** - None.

**Major repair items** - Electrode cleaning and replacement.

**Ease of repair** - Very good.

**Parts availability** - Very good.

## USERS' ASSESSMENT

### ADVANTAGES:

1) Very quick and easy means of determining pH levels. Use of this simple device eliminates the need to send soil samples to laboratories for simple pH tests. Samples need only be sent when the portable meter indicates that there may be pH problems.

### DISADVANTAGES:

None noted.

**OPERATIONAL GROUP:**

**12** Research and Control

**EQUIPMENT TYPES:**

**12.03** Drying Ovens

**MAKES AND MODELS IN USE:**

1) Blue M. Electric Co. Model SW17Ta
2) Despatch Industries Ltd., Model LDBI-69
3) Johns Scientific, Model 1330F

**MANUFACTURERS AND DISTRIBUTORS:**

1) Blue M. Electric Ltd.,
   138 Chatham Street.,
   Blue Island, Illinois
   60406 U.S.A.

   Telephone: (312) 385-9000

   Distributor: Canlab
   2390 Argentia Road,
   Mississauga, Ontario
   L5N 3P1

   Telephone: (416) 821-9660

2) Despatch Industries Ltd.
   Note: Despatch Equipment is now produced by:
   Ontario Ovens Inc.,
   61 Alness Street.,
   Suite 208,
   Downsview, Ontario
   M3J 2H2

   Telephone: (416) 665-6770

   Fax: (416) 736-1743

3) Johns Scientific Inc.,
   175 Hanson Street,
   Toronto, Ontario
   M4C 1A7

   Telephone: (416) 699-5555

   Telex: 06 217878

   Fax: (416) 699-6536

Despatch drying oven — St. Williams Nursery.

**CURRENT USERS AND NUMBER OF UNITS:**

| | | |
|---|---|---|
| Chapleau | 1 | Despatch |
| Dryden | 1 | Despatch |
| Gogama | — | |
| Kemptville | — | |
| Midhurst | 1 | Blue M. Electric |
| Orono | 1 | |
| St. Williams | 1 | Despatch |
| Swastika | 1 | Despatch |
| Thessalon | 1 | Johns Scientific |
| | 1 | Blue M. Electric |
| Thunder Bay | 3 | Despatch |

## TECHNICAL INFORMATION

### SPECIFICATIONS:

The following specifications are typical of the equipment required for most tree nursery uses.

| | |
|---|---|
| Chamber size: | |
| Width | - 76 cm |
| Height | - 56 cm |
| Depth | - 46 cm |
| Chamber Volume: | - 195 l |
| Overall Dimensions: | |
| Width | - 86 cm |
| Height | - 89 cm |
| Depth | - 58 cm |
| Electrical Requirements: | |
| Volts | - 240 |
| Amps | - 10.8 |
| Heater | - 2.4 km |
| Operating Range | - 60 – 204 ° C |
| Max. Load Capacity | - 45.4 kg |
| Max. Shelf Load | - 9.1 kg |
| Exhaust Capacity | - 0.17 m/min. |
| Fan Capacity | - 4.25 m/min. |
| Fan Rating | - 0.03 kw |
| Net Weight | - 77 kg |

General Information:

- Non-indicating, hydraulic non-mercury sensor thermostat
- Thermometer mount on exhaust vent for direct temperature readout
- Welded double wall steel construction
- Glass fibre insulation
- Thermally protected motor
- Doors, spring loaded, pull latch, silicone gasket
- Adjustable wire shelves

**OPTIONAL EQUIPMENT:**

1) Digital controls.
2) Temperature readout (Pyranometer).
3) Temperature limiting circuit.
4) Various timer circuits.

## TASK PERFORMED

Drying ovens serve as a contained heat source that is used for moisture analysis of soil and vegetation samples. The heat and air circulation provide rapid drying qualities that are used in the preparation of samples for these and many other forms of laboratory analysis.

## HOW IT WORKS

**GENERAL DESCRIPTION AND WORKING PRINCIPLE:**

A basic laboratory oven consists of a scratch-and chemical-resistant steel chamber fitted with a sealed insulated door. Inside the chamber several adjustable wire shelves maximize sample stacking and space utilization.

A heavy duty electrical heating element and circulating fan produce a uniformly heated environment within the chamber. The chamber is fitted with a self-sealing insulated door and is highly insulated to minimize heat loss.

Basic controls include a main power switch and a temperature setting rheostat. Some units also incorporate a temperature-limiting control to shut down the heating element should the temperature exceed a preset maximum. A mount is often placed into the oven exhaust vent for inserting a standard thermometer. Some makes can be optionally equipped with a temperature reading pyranometer as part of the control equipment.

**LIMITING FACTORS:**

1) Chamber size determines the maximum volume of sample material. Too large an oven will waste energy if it is generally used for small volumes. Too small an oven will limit the speed of testing if large volumes of samples are tested frequently.

## OPERATIONAL EQUIPMENT

**STAFF REQUIREMENTS:**

One person can easily operate and monitor the oven.

**SAFETY ASPECTS:**

Heat-resistant gloves should be available near the oven, particularly when laboratory glassware and metallic items are being heated.

**MAINTENANCE:**

Drying ovens are generally low maintenance items requiring only occasional repair and servicing.

**Major repair items** - The heating element and the circulating fan will in time require replacement.

**Ease of repair** - Basic repairs are straightforward. An electrician may be required for electrical repairs on ovens utilizing a 220 volt power source.

**USERS' ASSESSMENT**

**ADVANTAGES:**

1) Provides a simple, relatively quick means of performing moisture analysis of soil samples and nursery stock.

2) Speeds up most drying procedures significantly.

**DISADVANTAGES:**

None noted.

**OPERATIONAL GROUP:**

**12** Research and Control

**EQUIPMENT TYPE:**

**12.04** Rhizometer

**MANUFACTURERS AND DISTRIBUTORS:**

1) Lakehead University,
School of Forestry,
Thunder Bay, Ontario
P7B 5E1

Telephone: (807) 343-8110

**CURRENT USERS AND NUMBER OF UNITS:**

| | |
|---|---|
| Chapleau | 1 |
| Dryden | 1 |
| Gogama | 1 |
| Kemptville | — |
| Midhurst | 1 |
| Orono | — |
| St. Williams | 1 |
| Swastika | 1 |
| Thessalon | 1 |
| Thunder Bay | 1 |

Rhizometer with fluorescent light bank exposed.

**TECHNICAL INFORMATION**

**SPECIFICATIONS:**

The following are the specifications for the most recent version of the rhizometer.

| | |
|---|---|
| Sensors | - Four cadmium sulphide photocells (resistance: 0.75 ohms full light<br>0.00 ohms full darkness) |
| Zeroing | - 1000 ohm potentiometer (coarse) |
| Control | - 100 ohm potentiometer (fine) |
| Calibration | - 10-pole rotary switch |
| Controls | - 1/4 - 1/2 watt resistors; 180 ohms, 1.5 kilo-ohms, (2.2, 3.3, 4.7, 5.6, 8.2, 10.0, and 15.0) Mega-ohms<br>-1.0 mega-ohm potentiometer (variable control) |
| Measurement Device | - Digital DC Voltmeter with light-emitting diode (LED) readout |
| Cabinet | - 0-gauge stainless steel or 1.6 cm plywood<br>- Interior compartments painted flat black |

| | |
|---|---|
| Illumination | - array of 12, 30 cm fluorescent tubes<br>- 110 VAC circuit<br>- constant voltage transformer<br>- 3 four-pole, double-throw relays<br>- on/off switch<br>- starter switch and chokes |
| Diffusers | - .3 and .9 cm clear plastic sheeting with .48 glass beads sandwiched between the sheets |
| Masks | - .6 cm black acrylic plastic sheet |
| Cooling | - 110 VAC electric blower, capable of delivering 50 to 100 CFM of air flow |

**SPECIAL MODIFICATIONS:**

An in-line voltage regulator helps to stabilize line voltage fluctuations that cause much of the erratic behaviour noted by several of the nursery users. (Chapleau)

## TASK PERFORMED

The rhizometer is used for testing seedling root/shoot ratios and for performing quick non-destructive tests of root area index (R.A.I.).

## HOW IT WORKS

**WORKING PRINCIPLE:**

The roots of a seedling are stretched out on a opaque platform over a light source. An array of photocells above the platform react to the changes in light intensity reaching them from the source below the platform. The roots block some of the light reaching the photocells. A digital voltmeter displays the change in voltage across the cells. The voltage in turn can be related to the root area index for the seedling.

**GENERAL DESCRIPTION:**

The rhizometer is a photoelectric area measuring device composed of a light source, a sample chamber, a sensing circuit, and a user interface.

The device is housed in a stainless steel enclosure with three separate compartments mounted one above the other.

The lowest compartment houses a light bank consisting of twelve fluorescent tubes. A blower in the back of the chamber eliminates the heat generated by the lights by pumping warm air out of the enclosure into a separate rear compartment housing a constant voltage transformer. The warm air entering the chamber assists in stabilizing the light source by heating the transformer to eliminate the effects of temperature variations upon the transformer output.

The constant voltage transformer isolates the light bank from voltage fluctuations in the external power lines that would otherwise cause light intensity levels to fluctuate.

The next chamber above the light source is the sample chamber. This enclosure has an opaque glass bottom and is closed on all sides except for the front, which is a light-tight door. The interior is painted flat black to eliminate light reflections within the chamber.

Two diffuser plates are mounted between the glass platform and the light source below. These plates are fabricated from two sheets of plexiglass with glass beads sandwiched in between to ensure an even illumination over the entire area of the platform. They also insulate the sample platform from the heat of the light source.

A series of replaceable black masking sheets can be inserted over the glass sample platform to adjust the light aperture of the instrument. The proper aperture maintains maximum sensitivity for different sizes of seedlings.

The top of the sample chamber is the sensor mounting plate. Diagonal slots extend out from its centre towards the corners. Four cadmium sulphide photocells are mounted equidistant along the slots in the plate.

The sensors are connected to a Wheatstone Bridge circuit, a series of calibration and zeroing controls, and a digital voltmeter circuit. These items occupy the upper chamber of the unit. This equipment reads the light level in the sample chamber and converts it into a digital reading that the operator can correlate with the root area index of the seedlings.

To obtain an estimate of the RAI for a seedling, the rhizometer controls are calibrated and zeroed. The roots of the seedling are spread out evenly over the sample platform with a minimum of criss-crossing of the roots. When the roots are placed on the platform some of the light is blocked by the shading effect of the root system silhouette. The light reaching the sensors is decreased, thereby changing the internal resistance of the photocells. The sensor circuit translates this voltage change into a digital value that can be correlated with the RAI of the seedling.

**LIMITING FACTORS:**

1) Platform and chamber size limit the size of stock that can be accommodated.

**OPERATIONAL INFORMATION**

**STAFF REQUIREMENTS:**

One laboratory technician is required to operate the unit.

**MAINTENANCE:**

The sample platform should be cleaned frequently to ensure that there is no buildup of soil or debris on the glass that could intercept light and disrupt the accuracy of the measurement.

Dirt build-up caused by the cooling air circulation around the light bank necessitates frequent cleaning of the fluorescent tubes to prevent biasing the measurements.

Occasional replacement of the fluorescent tubes and startup exciters.

The batteries for the LED readout require frequent replacement.

**Special maintenance equipment required** - None.

**Major repair items** - Batteries for the LED circuit and fluorescent tubes and exciters for the light bank.

**Ease of repair** - Very good.

**Parts availability** - Very good.

**PRODUCTION RATES:**

Approximately one seedling per minute except with very large seedlings requiring two or more measurements.

## USERS' ASSESSMENT

**ADVANTAGES:**

1) The rhizometer provides a rapid means of estimating the root area index of samples of nursery stock. Other methods involving the measurement of all the roots on a seedling are very time-consuming and tedious.

2) Non-destructive. The entire measurement operation for a given seedling can be completed in approximately one minute, minimizing both handling and root damage due to drying.

**DISADVANTAGES:**

1) When measuring stock with heavy root growth, the accuracy of the measurement declines because of overlapping roots.

2) The instrument requires frequent calibration during use because of fluctuations in line voltage to the power supply. Chapleau Nursery suggests the addition of an in-line voltage regulator to lessen this problem.

3) The sample platform is very small for measurement of some of the larger stock types, so that roots must be cut into sections for measurement. The section RAI measurements must then be added to get a total figure for each seedling. This makes the unit unsuitable for non-destructive samples.

4) The measuring chamber is not large enough to accommodate some larger stock types particularly during non-destructive sampling. If the chamber door is left ajar to allow the top of the seedling to stick out of the chamber, then stray light can enter the chamber and upset the accuracy of the reading.

## TECHNICAL REFERENCES

1) Day, R. J., 1985. "Seedling root system measurement and the use and construction of the rhizometer. Thunder Bay, Ontario." *Silvicultural Report*, Lakehead University, School of Forestry, pp 21.

2) Morrison, I. K. and K. A. Armson, 1968. "The Rhizometer — a device for measuring the roots of tree seedlings." *For. Chron.* 44: 21—23.

**OPERATIONAL GROUP:**

**12** Research and Control

**EQUIPMENT TYPE:**

**12.05** Soil Compaction Tester

**MAKES AND MODELS IN USE:**

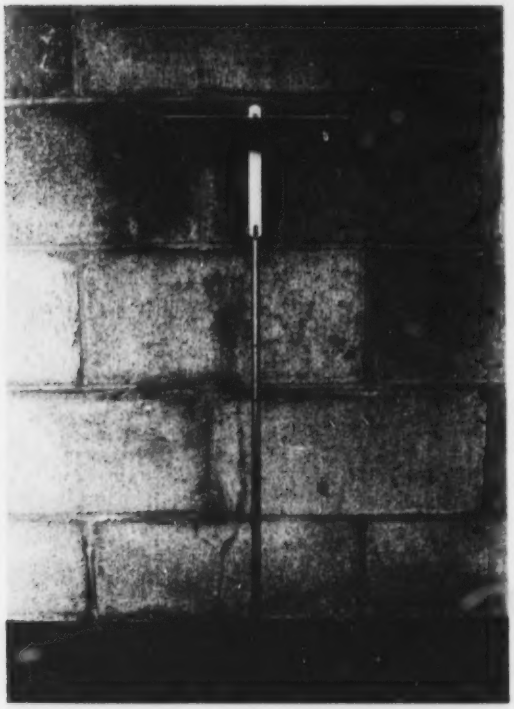
Dickey-john Corporation,
Soil Compaction Tester.

**MANUFACTURERS AND DISTRIBUTORS:**

1) Dickey-john Corporation,
Auburn, Illinois
62615 U.S.A.

**CURRENT USERS AND NUMBER OF UNITS:**

| | |
|---|---|
| Chapleau | — |
| Dryden | — |
| Gogama | — |
| Kemptville | — |
| Midhurst | — |
| Orono | — |
| St. Williams | — |
| Swastika | 1 |
| Thessalon | — |
| Thunder Bay | 1 |



Soil Compaction Tester.

**TECHNICAL INFORMATION**

**SPECIFICATIONS:**

| | | |
|---|---|---|
| Total length (cm) | | - 78.1 |
| Probe length (cm) | | - 60.3 |
| Probe diameter (mm) | | - 13 |
| Probe graduations (cm) | | - 7.6, 15.2, 22.9, 30.5, 38.1, 45.7 |
| | (in) | - 3, 6, 9, 12, 15, 18 |
| Handle length (cm) | | - 20 |
| Pressure Meter: | | |
| Max. rating | | - 100 bar |
| | | - 1500 PSI |
| Calibration | | - 0 - 200 PSI, low compaction |
| | | - 200 - 300 PSI, moderate compaction |
| | | - Above 300 PSI, severe compaction |

## TASK PERFORMED

A soil compaction meter (penetrometer) is used to measure the degree of soil firmness at various depths and locations within nursery compartments.

## HOW IT WORKS

### GENERAL DESCRIPTION AND WORKING PRINCIPLE:

The penetrometer consists of a stainless steel probe with a set of hand grips and a pressure gauge.

The probe is manually forced into the ground. As the probe tip passes down through the soil it encounters varying degrees of resistance to its passage caused primarily by changes in soil compaction. The variations in resistance are reflected in changes in the pressure readings displayed on the pressure gauge.

Soil compaction probe with graduated pressure gauge.

To quantify soil compaction the probe is fitted with a standard pressure gauge capable of reading from 0 to 100 bars of pressure. The gauge is also calibrated in pounds per square inch (P.S.I.) and is fitted with a colour coded template that displays light, moderate, and severe soil compaction levels. According to the manufacturer most agricultural crops grow well in the low range, fair in the mid range, and poorly in the severe upper range.

Graduation marks along the length of the probe facilitate easy recording of the depths of various compaction occurrences. Remedial soil cultivation practices may be planned based upon the compaction level and depth information collected with the device.

Several tests should be made throughout each field or compartment being evaluated to eliminate chance that localized soil conditions might influence test results for an entire field. It is also wise to make comparison tests in undisturbed soil adjacent to each nursery compartment. By maintaining a historical file of all the information collected from year to year and at various times during the year (i.e., before and after tillage) a nursery manager will be able to receive a clearer picture of the results of current tillage practices and make optimum decisions regarding future modifications.

### LIMITING FACTORS:

1) Changes in soil texture between or within soil compartments, or at various depths in the soil horizons will influence the readings produced by the compaction meter. Factors such as these should be identified in order to obtain the most useful decision-making information with the device.

2) Changes in soil moisture influence the compaction level registered by the unit. In order for compaction readings to be comparable from one time of measurement to the next the soil moisture should be approximately the same during each test.

## OPERATIONAL INFORMATION

### STAFF REQUIREMENTS:

One person is required to operate the device and record the information obtained.

**MAINTENANCE:**

The device is very simple in design and requires little, if any, maintenance. The gauge may initially or from time to time require zeroing, particularly if it has been dropped or bumped severely.

**Ease of repair** - Very good.

**Parts availability** - Good.

**USERS' ASSESSMENT**

**ADVANTAGES:**

1) Allows nursery managers to have quantitative soil compaction information to assist in planning soil tillage activities.

**DISADVANTAGES:**

None noted.

**OPERATIONAL GROUP:**

**12** Research and Control

**EQUIPMENT TYPE:**

**12.06** Tensiometers (permanent and portable models)

**MAKES AND MODELS IN USE:**

1) Soilmoisture Equipment Corp.

Models: 2725 Jet Fill Tensiometer

2900F Quick Draw Moisture Probe

**MANUFACTURERS AND DISTRIBUTORS:**

1) Soilmoisture Equipment Corporation,
P. O. Box 30025,
Santa Barbara, California
93105 U.S.A.

Telephone: (805) 964-3525

Telex: 65-8424

Fax: (805) 683-3189

Distributor: Hoskin Scientific Ontario,
1156 Speers Road,
Oakville, Ontario
L6L 2X4

Telephone: (416) 842-0237

Telex: 06-982366

**CURRENT USERS AND NUMBER OF UNITS:**

| | Permanent | Portable |
|---|---|---|
| Chapleau | 10 | 1 |
| Dryden | 8 | None |
| Gogama | 8 | 1 |
| Kemptville | 16 | 5 |
| Midhurst | 30 | 3 |
| Orono | 54 | 2 |
| St. Williams | 40 | 1 |
| Swastika | 28 | 2 |
| Thessalon | 5 | 2 |
| Thunder Bay | 90 | 3 |

Tensiometer at Swastika Nursery.

**PRICE OF CURRENT MODELS:**

| | Model No. | Price/Unit |
|---|---|---|
| Permanent Tensiometer Models: | | |
| | 2725 A 6" (15.2 cm) | $ 56.10 |
| | 2725 A 12" (30.5 cm) | 57.35 |
| | 2725 A 18" (45.7 cm) | 59.00 |
| | 2725 A 24" (61 cm) | 60.25 |
| | 2725 AR 6" (15.2 cm) | 64.35 |
| | 2725 AR 12" (30.5 cm) | 65.60 |
| | 2725 AR 18" (45.7 cm) | 67.25 |
| | 2725 AR 24" (61 cm) | 68.50 |

Note: Models with the "A" suffix are models with fixed pointer gauges. Models with the "AR" suffix are equipped with recalibrator-type gauges.

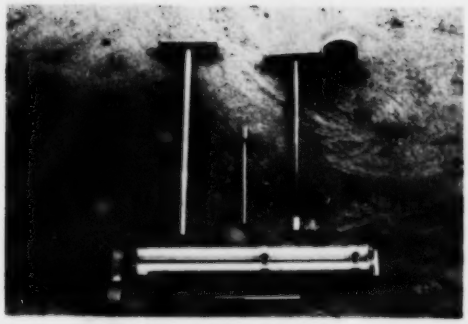
| | | |
|---|---|---|
| Required Accessory Equipment: | | |
| | 2710K Service Kit | $75.25 |
| Portable Models: | 2900FL 12" Quick Draw Probe | $326.70 |
| | 2900FL 18" Quick Draw Probe | $346.50 |

**TECHNICAL INFORMATION**

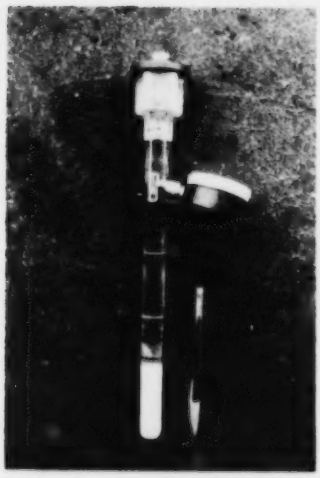
**SPECIFICATIONS:**

**1) Permanent Tensiometer, Model 2725**

| | |
|---|---|
| Tube | - Available in lengths from 15 to 152 cm long |
| | - 2.2 cm in diameter |
| | - Main body of tensiometer is constructed of a heavy walled tube of rigid clear plastic |
| | - Threaded base and top for ceramic tip and reservoir cap respectively |
| | - Operating depth indicator moulded into the side of the main tube of the tensiometer |
| | - Moulded, angled side port for the vacuum gauge. Port is threaded with 1/4-18 NPT thread |
| Gauge | - 5 cm |
| | - fixed or recalibrator gauge pointer |
| | - 0.6 cm NPT gauge stem |
| | - 0 to 100 centibar gauge range |
| | - Gauge is housed in a temperature-adjusting outer casing which protects the gauge against weather and shock |
| | - A venting screw allows for compensation against variations in altitude |
| Joints | - All sealed using O-ring seals |
| Sensing Tip | - Porous ceramic tip is threaded onto the main tube |
| Tube Cap | - Detachable reservoir cap holds enough water to last for several months under normal operation |
| | - Reservoir button automatically purges any accumulated air from the tensiometer and recharges the main tube with water |



Portable tensiometer showing carrying case (bottom), coring tool (left), moisture probe with gauge (right).



Permanent tensiometer with reservoir at top, porous tip at bottom.

in anaerobic soil conditions, in which the seedlings literally drown due to the lack of oxygen reaching the roots.

Water that filters down into the soil fills the gaps between soil particles. Once the gaps are filled, additional water runs off freely. As the soil dries out the remaining water no longer fills the gaps but instead forms a film around the individual soil particles. The film of water is held to the particles by molecular forces. As the soil continues to dry, the water film becomes thinner and the remaining water molecules become subject to increasing forces which bind the water molecules to the soil particles. The result of this increasing difficulty in extracting water from the soil is that plants must work harder to obtain the necessary moisture and nutrients. At some point, commonly referred to as the "wilting point", the seedling roots are no longer able to develop enough internal suction to extract the required moisture from the soil.

In growing nursery stock, or any crop, the goal is to maintain the soil moisture at a level where there is adequate air between the soil particles for the roots to obtain oxygen and sufficient moisture to ensure an optimum soil moisture tension for the best seedling growth. (Note: Soil moisture tension is a term used to describe the force required to extract water from the soil.)

When a tensiometer is first inserted into the soil the tube is completely filled with water and the cap tightly sealed. If the surrounding soil is not saturated, water will be sucked through the porous tip by the force of the soil moisture tension. As water is pulled from the tube, a vacuum is created within the tube. At some point the force of the vacuum will equal the force of the soil moisture tension. When this occurs, the flow of water from the tube will cease.

The vacuum within the tube is directly related to the soil tension. A vacuum, calibrated in centibars, measures the vacuum, hence the soil moisture tension.

If water is applied naturally or through irrigation to the soil, it will filter down amongst the soil particles and decrease the soil tension. The suction in the tensiometer tube will now be greater than the soil tension. The suction in the tube will draw water from the surrounding soil back through the porous tip into the tube until an equilibrium is once again established. The vacuum in the tube will decrease and display a correspondingly lower soil tension value. The opposite would occur if the soil were to continue to dry out between two consecutive readings of the tensiometer.

Soil tensiometers are produced in two basic forms, permanent and portable varieties. The portable model comes equipped with a carrying case, a coring tool, and the probe. The case is constructed with two compartments: one holds the coring tool; the second holds the probe and is equipped with a moisture reservoir in the bottom end to keep the porous tip on the probe wet.

To operate the portable model, the coring tool is pushed into the soil to remove a core of soil sufficient to insert the probe to the desired depth for measurement.

The permanent tensiometer is designed to be inserted at the beginning of the season and left for the duration of the season. It consists of a rigid plastic tube with a round porous probe end and a plastic reservoir cap on the upper end. As with the portable model, a hole must be cored for insertion of the tensiometer. A tool is available that will produce a hole into which the probe will fit snugly and to the proper depth. The porous tip must be in full contact with the soil or erroneous readings will result.

Permanent tensiometers function continuously. To maintain consistent, accurate readings throughout the season, air buildup must be released from the tube and the tube water level must be topped up. Permanent tensiometers are equipped with a reservoir chamber and an air release button on the upper end of the probe. The air release button must be operated regularly to vent the tube and refill the tube from the reservoir.

**LIMITING FACTORS:**

1) Frost can cause the water in permanent tensiometers to freeze and burst the meter. A 50/50 mixture of ethylene glycol and water can be used to eliminate this problem.

2) In soils with high silt or clay content tensiometers tend to be considerably slower at reading soil tensions. Tensiometers therefore tend to lose some efficiency with finer textured soils.

3) Permanent tensiometers require additional caution on the part of equipment operators. Unless tensiometers are properly marked and equipment operators particularly cautious, tensiometers are easy to run over.

## OPERATIONAL INFORMATION

**STAFF REQUIREMENTS:**

One person is required for the initial set-up of permanent tensiometers, for taking daily readings from the meter, and for maintaining the tensiometers in good working condition.

Portable tensiometers require that the operator make daily trips to the compartments to set up the tensiometer and record the soil suction reading.

**SAFETY ASPECTS:**

There are no specific safety requirements.

**MAINTENANCE:**

**Portable Model 2900F**

The instrument is relatively robust and generally requires little regular maintenance. Most of the maintenance activities are only performed initially or as required from time to time.

**Venting the dial gauge.** This operation may be required after relatively large changes in air pressure such as those due to altitude changes during initial delivery. Venting will equalize pressure inside the gauge with external air pressure, thereby zeroing the pointer.

**Adjusting the dial gauge pointer.** If after venting the gauge the pointer still is not zeroed, the pointer itself may require zeroing via an adjustment screw just inside the venting hole.

**Flushing and replenishing the probe case.** Periodically fill probe compartment of the carrying case with water and empty. This action will wash out accumulated soil particles and re-wet the sponge water reservoir. This operation should be part of the post season maintenance in preparation for winter storage.

**Testing response time**, defined as the time required for the tensiometer reading to drop from 50 to 10 centibars when the ceramic sensing

**2) Portable Model: 2900 F**

| | |
|---|---|
| Coring tool | - Made of chromium steel<br>- Available in lengths to match the probe length used |
| Tube | - Available in lengths: 30 to 46 cm<br>- Fabricated from chromemoly steel tubing |
| Carrying Case | - Available in lengths to match the probe length used<br>- Compartment provided for both the coring tool and the moisture probe. Clips provided for attaching the cleaning rod to the side of the carrying case |
| Joints | - Sealed using O-rings |
| Gauge | - Recalibrator-type gauge the same as that used on the permanent tensiometer model |
| Null Adjustment | - Knob on probe handle is used to adjust the probe for optimum operation |

**OPTIONAL EQUIPMENT:**

1) Extension tubes are used to extend the length of the permanent model tensiometers. Model 2720 L60 will extend the length of the Model 2725 tensiometer by 152 cm.

**SPECIAL MODIFICATIONS:**

1) A 50/50 mix of water and ethylene glycol was substituted for pure water in the permanent tensiometers, to prevent frost damage to the tensiometers.

**COMPLEMENTARY EQUIPMENT:**

1) Soil Auger for installation of permanent tensiometers. Auger is 5 cm in diameter and 1.52 m long. (Soilmoisture Equipment Corp., Model 230 D2)

2) Insertion tool for permanent models. Available from Soilmoisture Equipment Corp., Models: 240 L30, L54, and L78. These tools are each 2.2 cm in diameter and 76, 114, and 198 cm in length respectively.

## TASK PERFORMED

Permanent and portable tensiometers are used for determining the soil moisture levels of nursery fields as an aid in setting irrigation schedules.

## HOW IT WORKS

**WORKING PRINCIPLE:**

A tensiometer is constructed of a sealed tube with a porous tip on the lower probe end, and a removable cap and a vacuum gauge on the other end.

The principle behind its operation is based upon the fact that soil, when viewed on the microscopic scale, is composed of a multitude of different sized particles with interconnecting spaces filled by air pockets and water. For proper seedling growth the goal is to maintain a balance of oxygen and water in the soil. Too much water will result

tip is submerged in water. A long response time indicates that there is air in the probe. Air tends to expand as the pressure is reduced and compress as the pressure increases. This action results in a "spongy" tensiometer action.

**Replacement of the porous ceramic tip** if it becomes broken or cracked in any way. The slightest hairline crack will result in incorrect readings. The pores in the ceramic tips will also tend to become plugged over a period of time, resulting in a slow response time.

**Permanent Model: 2725**

**Air removal** is required on a weekly or longer basis but it is suggested that the reservoir button be depressed as standard practice after each reading to keep the amount of air in the unit to a minimum and ensure maximum sensitivity.

**Replace the reservoir cap** with a refilled cap as required to maintain a supply of water for servicing the probe. Alternatively the cap may be filled by lifting the edge of the neoprene reservoir cover.

**Remove** all tensiometers prior to the onset of freezing winter conditions to prevent frost damage to the gauge and tube.

## USERS' ASSESSMENT

### ADVANTAGES:

1) Permanent models are left in the ground for the duration of the season. There is no need to spend time reinserting the probe for each reading. Since the permanent probe is always mounted in the same location with no disturbance around the probe, the readings tend to give a more accurate picture of the relative soil moisture trends over time. Portable tensiometers are inserted into a different set of soil conditions each time they are used. This adds another degree of error to the readings.

2) Soil moisture can be determined very quickly. With portable tensiometers, a reading can be determined in a matter of minutes. Using a permanent tensiometer the reading can be obtained in second

### DISADVANTAGES:

1) Tensiometers do not have a means of giving a value for per cent soil moisture. If such information is required then a separate soil sample must be taken for analysis at the same time the soil suction readings are taken.

**OPERATIONAL GROUP:**

**12** Research and Control

**EQUIPMENT TYPE:**

**12.07** Soil Auger

**MAKES AND MODELS IN USE:**

1) Wisconsin Soil Auger, Models P and K

**MANUFACTURERS AND DISTRIBUTORS:**

1) Oakfield Apparatus Company,
Oakfield, Wisconsin

Distributor: 1) Canadian Forestry Equipment Ltd.,
Unit 15,
7355 Torbram Road,
Mississauga, Ontario
L4T 3W3

Telephone: (416) 678-1586

2) Hoskin Scientific,
1156 Speers Road,
Oakville, Ontario
L6L 2X4

Telephone: (416) 842-0237

Telex: 06-982366

**CURRENT USERS AND NUMBER OF UNITS:**

| | |
|---|---|
| Chapleau | 1 |
| Dryden | 3 |
| Gogama | 1 |
| Kemptville | 3 |
| Midhurst | 5 |
| Orono | 3 |
| St. Williams | 3 |
| Swastika | 6 |
| Thessalon | 1 |
| Thunder Bay | 4 |

Wisconsin soil auger.

## TECHNICAL INFORMATION

### SPECIFICATIONS:

| | |
|---|---|
| Total Length | - 50 cm |
| Core Chamber Height | - 30 cm |
| Handle Length | - 20 cm |
| Chamber Diameter | - 1.0 cm I.D.<br>- 2.5 cm O.D. |
| Tip Orifice Diameter | - 1.8 cm |
| Tip | - replaceable, brass |
| Construction | - 16-gauge steel<br>- nickel chrome-plated to resist abrasion |

### OPTIONAL EQUIPMENT:

1) Additional replacement brass tips.

## TASK PERFORMED

Soil augers are used to obtain samples of the upper soil horizon in nursery fields. The samples are taken for determination of per cent soil moisture and for other chemical analysis procedures.

The soil auger is also used to obtain soil samples for simple hand checks of soil moisture.

## HOW IT WORKS

### WORKING PRINCIPLE:

The tip of the auger tube is placed on the soil surface. Downward pressure is applied to the probe while rotating the handle, causing the probe tip to cut into the soil surface.

As the tip moves down through the soil a core of soil is forced up through an aperture in the probe tip into the hollow core of the tube.

When the desired depth is reached the probe is pulled from the soil. Because the core sample expands slightly as it moves up into the tube it does not slide back out through the tip aperture as the probe is lifted from the soil. Instead the slightly smaller aperture of the tip helps to hold the soil core in the tube. Once the probe is completely withdrawn from the soil the sample can be recovered through an opening in the side of the tube or through the tip opening.

### GENERAL DESCRIPTION:

The soil auger consists of a metallic rod with a T-type handle. A hollow sampling tube is attached to the lower end of the rod and handle. One side of the tube section is cut away to facilitate the observation and removal of soil cores in the tube.

The tube tip is a short, threaded brass section that screws onto the end of the sampling tube. The tip has a bevelled edge for cutting into the soil. The inside diameter tapers towards the end of the tip so that the opening at the end of the tube has a smaller diameter than the inside diameter of the main tube section.

**LIMITING FACTORS:**

1) As the clay content in the soil increases, the coring process slows and more energy is required to obtain samples.

2) Sticks, stones and other debris will impede the proper penetration of the probe into the soil.

## OPERATIONAL INFORMATION

**STAFF REQUIREMENTS:**

One person is required to operate the auger.

**SAFETY ASPECTS:**

No specific safety recommendations.

**MAINTENANCE:**

The device is very simple in design and is relatively maintenance-free.

Occasionally the tip will require sharpening to maintain the bevelled cutting edge.

The tip can be replaced should it become damaged or once repeated sharpenings have begun to increase the size of the tip aperture.

**Special maintenance equipment required** - None.

**Major repair items** - Tips - sharpening and replacement.

**Ease of repair** - Excellent.

**Parts availability** - Very good.

## USERS' ASSESSMENT

**ADVANTAGES:**

1) A soil sample can be obtained much faster with an auger than with a shovel. The auger can be quickly pushed into the soil. The probe end is then placed in a plastic sample bag and the sample dumped into the bag.

The shovel method requires that a small hole be dug to the desired depth. A representative sample must then be scooped into the sample bag or container.

2) The auger provides much less disturbance to the field than does soil sampling with a shovel. This is particularly advantageous when samples are to be taken from within or near nursery-beds.

**DISADVANTAGES:**

None noted.

## APPENDIX A

## ONTARIO MINISTRY OF NATURAL RESOURCES FOREST TREE NURSERIES

| NURSERY ADDRESS | TELEPHONE |
|---|---|
| **CHAPLEAU NURSERY**<br>190 Cherry St.,<br>Chapleau, Ont. P0M 1K0 | (705) 864-1710 |
| **DRYDEN NURSERY**<br>P.O. Box 90,<br>Wabigoon, Ont. P0V 2W0 | (807) 938-6326 |
| **GOGAMA NURSERY**<br>Gogama, Ont. P0M 1W0 | (705) 894-2000 |
| **KEMPTVILLE NURSERY**<br>G.H. Ferguson Forest Station,<br>R.R. #4,<br>Kemptville, Ont. K0G 1J0 | (613) 258-8355 |
| **THESSALON NURSERY**<br>P.O. Box 310,<br>Thessalon, Ont. P0R 1L0 | (705) 842-2631 |
| **MIDHURST NURSERY**<br>Midhurst, Ont. L0L 1X0 | (705) 728-2900 |
| **ORONO NURSERY**<br>P.O. Box 119,<br>Orono, Ont. L0B 1M0 | (416) 983-9147 |
| **ST. WILLIAMS NURSERY**<br>Southwestern Region,<br>R.R. #1,<br>St. Williams, Ont. N0E 1P0 | (519) 586-3576 |
| **SWASTIKA TREE NURSERY**<br>P.O. Box 129,<br>Swastika, Ont. P0K 1T0 | (705) 567-3372 |
| **THUNDER BAY NURSERY**<br>Thunder Bay Forest Station,<br>R.R. #1,<br>Thunder Bay, Ont. P7C 4T9 | (807) 939-2561 |